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Remarks on Reaction Water Wheels used in the United States; and on the Turbine of M. Fourneyron, an Hydraulic Motor, recently used with the greatest success on the continent of Europe. By Ellwood Morris, Civil Engineer.

[CONCLUDED FROM PAGE 227.]

On Turbine Water Wheels.—Having completed our remarks upon *reaction water wheels*, by endeavouring to show *that they are not superior in effect to undershot wheels*, unless when acting in backwater; we will now proceed to consider the *turbine* of M. Fourneyron, which—whether employed upon falls as low as three feet, or as high as 354 feet—whether immersed in backwater or not—realizes continually, with remarkable uniformity, a proportion of useful effect *quite as great*, in comparison with a given power expended, as can be obtained from the best overshot wheels, working under the most favorable circumstances; in other words, whilst the co-efficient of effect belonging to the turbines, continually approximates to 0.800, it remains nearly invariable, under all circumstances of fall and position; this peculiar wheel possessing the remarkable property of being equally effective and suitable, in almost every situation where water wheels can be used as motors.

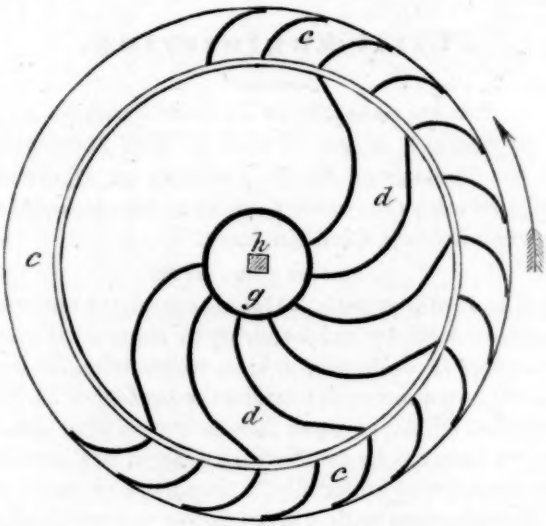
The *turbine*, or water wheel invented by M. Fourneyron, is like

the reaction wheel, formed of cast iron, (often in a single piece,) and like it, is usually made to revolve horizontally about a vertical axis.

In the following sketches, *c c* represents a horizontal section of the wheel rotating in the direction of the arrow, about a vertical axis passing through a pipe attached to the *fixed disk d d;* which disk is surmounted by a series of *guides,* curved in a particular manner, whereby the water is conducted to the wheel, made to issue tangentially, and press upon the curved buckets perpendicularly, or nearly so, thus producing a revolving motion.

The admission of water from the upper level to act upon the wheel, is regulated by an annular sluice gate, which envelopes the curved guides, and shuts down upon the fixed disk; when this sluice gate is raised, the water issues out between the curved guides and turns the wheel; when closed, a water tight joint is formed, and none can pass to the lower level; all which will be easily comprehended, from an examination of the following description and diagrams.

Fig. I.



General Description of a Turbine.

Fig. I exhibits part of a horizontal section of a *turbine;* in which *c c c* shows *the wheel* turning in the direction of the arrows; *d d, the fixed disk,* with its curved guides attached, the spaces between which are the sluices whence the water issues, and presses upon the curved buckets of the wheel; *g, the shaft pipe,* which sustains *the fixed disk* in an unchangeable position upon its lower extremity, and is itself

sustained at its upper end by the carpentry above the forebay; through this pipe *the shaft* of the wheel *h* rises to communicate motion to the works driven by *the turbine;* the open annular space between *d* and *c* represents the place of the sluice gate, which is a short portion of a thin hollow cylinder of cast iron, moving vertically, in contact with *the fixed cylinder n n,* at its upper part, and closing down water tight upon the fixed disk; wooden blocks are screwed upon the inside of the annular sluice gate, which slip between the curved guides and are rounded above and below, in order to improve the ajutage, and thus facilitate the efflux of the water, as is more clearly seen at *f* and *e*, Fig. II.

Fig. II.

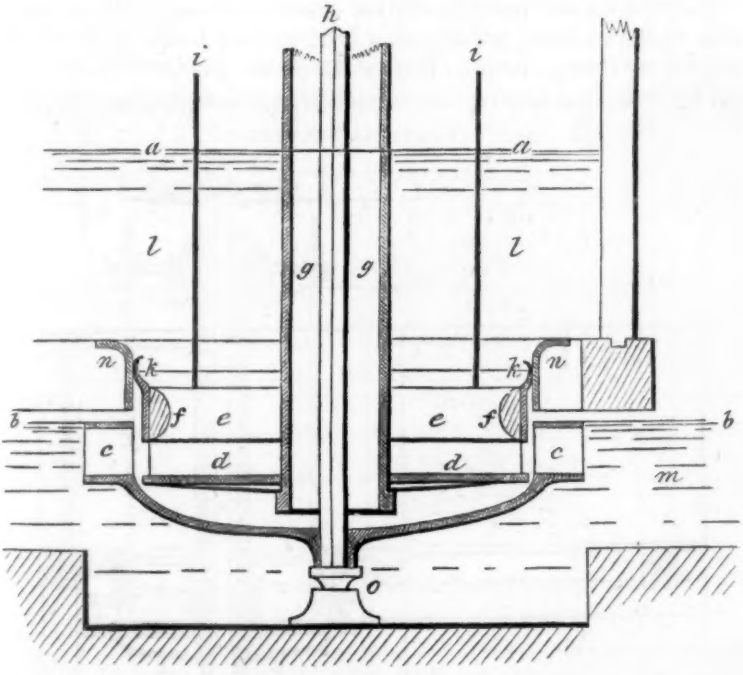
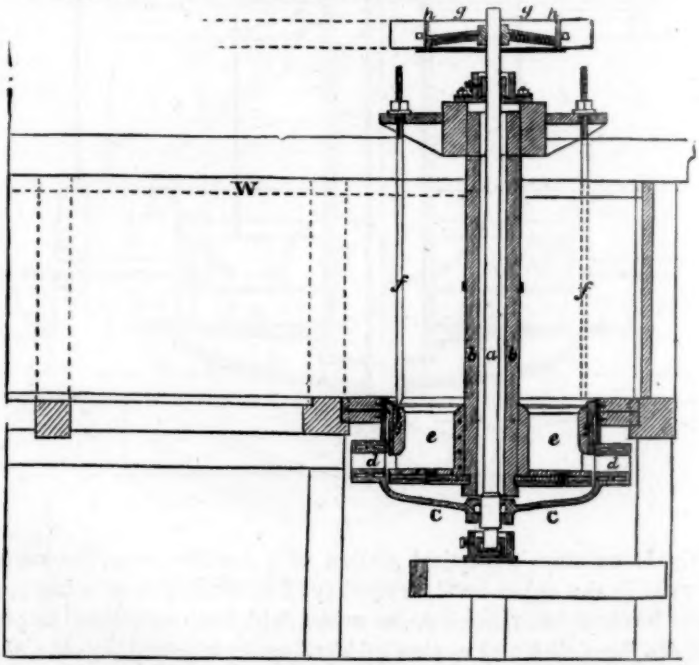


Fig. II exhibits a vertical section of a *turbine; a a,* the surface of water in the upper level, or forebay; *b b,* the surface of water in the lower level, or tail race; *c c, the wheel* with buckets curved in plan; *d d, the fixed disk* and *curved guides* firmly supported by *the shaft pipe g; e e, the annular sluice gate,* with its wooden internal cushions *f f,* to improve the ajutage; *g g, the shaft pipe; h, the shaft* upon which *the wheel c c* is firmly fixed at its lower part, so as to carry the shaft with it in its movement of rotation; this shaft runs upon a suita-

ble step, or pivot, at *o: i i*, two vertical rods, which, with a third not seen in the sketch, are attached to the annular sluice gate at equal distances apart, and which being all acted upon equally by an arrangement of screws and spur gear, raise or depress the annular gate with perfect regularity; *k k, a leather collar*, extending entirely around the upper circumference of the annular sluice gate, which collar being pressed outwards by the water, against the concave surface of the concentric *fixed cylinder n n*, effectually secures this joint in a manner that prevents leakage; *l l, the forebay*, the water of which has free communication with the sluices of the turbine, by the whole circular space from *k* to *k*; and finally, *m* is the *tail race* through which the water escapes, after having actuated the turbine.*

To illustrate still more clearly the construction and mode of operation of the turbines, we subjoin a brief extract from a paper on this subject, by George Rennie, Esq., F. R. S.. &c., published in this journal for 1840, and also reprint the wood cuts accompanying that paper.

Fig. III. VERTICAL SECTION.



* We will here observe that the curves of the buckets of the turbine, and of the guides upon the fixed disk, must be traced in a particular manner, which it requires some study to master; and that without a close attention to this point, these wheels *may fail* to realize a proper degree of useful effect, as was the case with several in France, which were not constructed with sufficient care.

Description of the Engravings.

L, beam with which the lever of the brake is connected by a spring balance marked D. W, water level. F, friction wheel. D, dynamometer.

a, Main axle of the turbine.

b b, Shaft pipe enclosing it

C C, The lower part, or shell, of the turbine wheel.

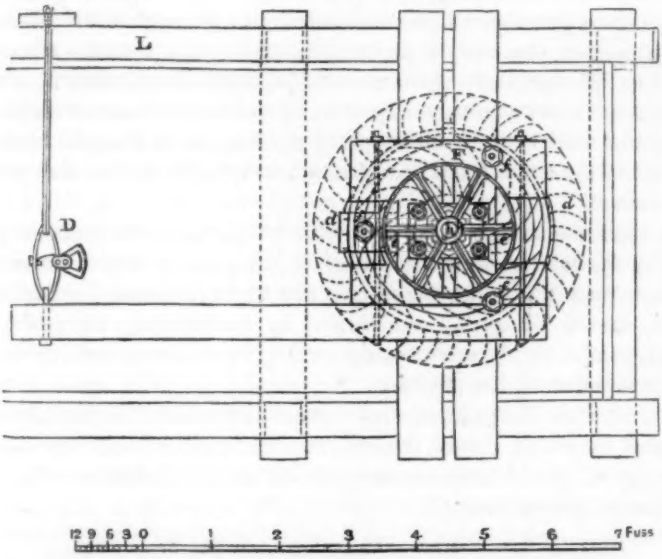
d d, The curved buckets, or vanes, against which the water presses in escaping between them from the wheel.

e e, The curved guides upon the fixed disk.

f f, Rods and screws for manœuvring the annular sluice gate.

g g, The annular sluice gate.

Top View. Fig. IV.



"*Operation.*—To set the machine in motion, the sluice *g g* is drawn up by means of the screws and bolts *f f*. Then the water which is continually resting on the fixed disk P P, with the pressure of the whole fall, immediately issues out between the curved guides, and impinging upon the curved buckets of the turbine, causes it and the main shaft, with all its machinery, to revolve rapidly."

Such is the description of Mr. Rennie, which is reprinted at the risk of repetition, with the particular purpose of drawing attention to the

Brake, or Friction Dynamometer, of M. De Prony, by means of which the useful effect of the turbine has been usually measured.

The *brake* consists simply of two stout pieces of wood, embracing a smooth wheel firmly fixed upon the shaft of the turbine, and cut out concave to fit, or nearly fit, this wheel; these collar beams are connected together, by two screws with heavy nuts and washers, by means of which they may be made to embrace the fixed wheel, with any necessary degree of force, or even to stop its motion.

To one of these beams, a long lever is attached, and connected at its outer end, either by a spring balance or a scale and weight, with some fixed point of the building.

This is the whole machine (see the sketches) which, as a dynamometer, is remarkably accurate, as well as perfectly simple; all that is necessary is, that the friction should be made regular, and the wooden collar beams prevented from burning; both these objects are effectually attained, by the simple precaution of causing a small stream of water to fall constantly upon the rubbing surfaces of contact.

Then the screws being set up with any moderate force, weights are added if a scale is used, or the spring dynamometer is made to act, so as to keep the lever fixed in a position perpendicular to the pull of the balance.

If, when the shaft is revolving with speed, the lever remains regulated by the balance weights applied, in the position above mentioned without much vibration, *the weight placed in the scale, (or indicated by the spring balance,) multiplied by the velocity the end of the lever would take if free to revolve,* will give a correct measure of the net useful effect of the machine.

It was with this simple and correct instrument, devised for such purposes by M. de Prony, that all, or nearly all, of the experiments made by M. Morin and others, upon the economical value of the turbine have been performed.

Comparison between Reaction and Turbine Wheels.

The wheel of the turbine alone, is not very dissimilar in general appearance to the reaction wheel, though totally different in its mode of action.

The difference lies in the addition of a fixed disk surmounted by curved guides, and in an entirely different curvature given to the buckets; these variations change the whole character of the machine.

The *reaction wheel* derives its motion solely from the *reaction* of the spouting water against very oblique vanes, so curved as to facilitate this spouting to the utmost extent; whilst the water is left free to take its own course, in entering the wheel.

In the *turbine*, on the contrary, the effect is to restrain, as much as possible, the spouting of the water at a high velocity, and force it to act against the vanes, or buckets, almost perpendicularly *by its pressure*, and not obliquely *by its impulse:* hence it is that the curved guides are established to conduct the effluent water, and constrain it to act tangentially against the vanes, which are curved around so much as to prevent the water from leaving them until its pressure is exhausted, or until, thrown outwards by centrifugal force, it drops from the wheel inert and almost destitute of motion.

In the *reaction wheel*, the greater the velocity of the spouting water the greater is the impulsive reaction, and consequently the greater is the effect produced—but in the *turbine*, the less the velocity of the effluent water, and the less its impulse, the greater is the effect, because its full pressure is then made to act with more advantage.

In fact the turbine is so planned as to satisfy, *practically*, the theoretical condition which the European philosophers have established as necessary to the production of a maximum effect in water wheels, viz: *that the water must enter the wheel without shock, and leave it without velocity*—or in other words, that it must be a wheel of pressure and not of impulse—which condition, fulfilled by the turbine, is not satisfied, but reversed by the reaction wheel; and hence it is that the latter ranks amongst wheels of impulse, and has an effective co-efficient of only about 0.400, whilst the former takes its place amongst the wheels of pressure, and has a co-efficient approximating to 0.800, or double that of the other.

In fine, if we may be allowed to make such a comparison, turbines are horizontal *overshot wheels*, and reaction wheels are horizontal *undershots;* both being similar in action and effect to these, except that in consequence of the water acting in both, upon the whole circumference at once, under full pressure, they admit of being made much smaller in diameter than overshot or undershot wheels; on both of which the water of the fall acts efficiently only by a part (sometimes a very small part) of the periphery.

Experiments demonstrating the economical value of Turbine Water Wheels.

The first *turbine* established by M. Fourneyron, after he had completed the plan of his invention, was applied to a saw mill at Pont sur l'Ognon, in France, and a series of experiments were there made by him, to satisfy himself concerning its value as a motor; but although these were perfectly satisfactory, he waited with commendable caution, until he had constructed and put in action several other turbines, (all

of which performed well,) before he publicly communicated the results.

Having obtained a patent for his invention in France, he wrote a very able essay which is published in the "Bulletin de la Société D'Encouragement pour l'Industrie Nationale," for 1834, and gives a full description of the invention and of several turbines which he had then constructed; one of them upon a fall of four and a quarter feet, being of fifty horses power. The society above referred to, awarded to M. Fourneyron a prize of 6000 francs for the successful introduction of his wheels into use.

The great advantages possessed by the turbines over other known hydraulic motors, as displayed in their work at various mill seats, soon attracted considerable attention upon the continent of Europe; and in 1837, Capt. Arthur Morin, of the French Artillery, a distinguished experimental philosopher, took up the subject with the view of fixing decisively, the economical value of this motor; and he made a careful, impartial, and prolonged series of experiments upon turbines of large size, which were then driving extensive mills at Müllbach and Mousray, in France.

The record of these trials, with remarks by M. Morin, was published at Metz and Paris in 1838, under the title of "*Experiences sur les Roues Hydrauliques a axe vertical appelées Turbines,*" from this work we have derived most of the facts herein embodied, and it will be found well worth an attentive perusal, by persons interested in these subjects.

About the same time also, M. Dieu, a major of Artillery, made experiments upon the useful effect of a turbine, established in the mill of Lepine, which trials were quoted and reduced by M. Morin, in the work above referred to.

Experiments upon the available power of a turbine, were also tried upon one which was established at St. Blaise, in the Black forest, and actuated by a stream of water having the enormous fall of 354 feet!

Finally, connected with a proposition made by M. Arago, to create a small fall in the Seine at Paris, and employ turbines upon it to supply that city with water, in lieu of other contrivances now existing for that purpose; a commission was appointed by the Prefect of the Seine to conduct a series of experiments upon the turbine of Inval, and they particularly examined the effect of backwater upon turbines, arriving, as the others had done before, at the conclusion that the coefficient of useful effect was not sensibly diminished, even when the turbine was deeply immersed in backwater.

As the writer believes that no experience has yet been had in America, with *turbines* at large, he is unable to quote any experi-

ments made here, upon a working scale; but in this case, any further trials than those made upon the continent of Europe, seem quite unnecessary to establish the value of this machine; for those experiments —made by different individuals, at different periods of time, upon turbines of different size, and actuated by different falls of water—corroborate each other so completely as to fix the value of the turbine, as an hydraulic motor, in a manner so definite and conclusive, as to be wholly beyond the reach of cavil or dispute.

The following table contains a very brief summary of some of the results of the numerous experiments above refered to; M. Morin alone having made 48 separate experiments upon the turbine of Moussay, and 84 upon that at Müllbach.

Situation of the Turbine.	Fall of water in feet.	Volume of water used in a second in cubic feet.	Number of turns made by the wheel in a minute.	Useful effect in horses power.	Ratio of the useful effect to the power; or co-efficient of effect.	Name of the Experimenter.
Moussay,	$24\frac{6}{10}$	26	190	45	0.690	M. Morin.
Müllbach,	12	$88\frac{3}{10}$	60	91	0.780	Ditto.
Lepine,	$6\frac{6}{10}$	$15\frac{1}{2}$	75	$9\frac{1}{4}$	0.772	M. Dieu.
Inval,	$6\frac{1}{4}$ to 1	———	———	———	0.770 to 0.650	A Commission.
St. Blaise,	354	$1\frac{1}{10}$	2300	40	0.800 to 0.850	M. Fourneyron.
Pout sur l'Ognon,	$4\frac{1}{2}$	$13\frac{1}{4}$	50	$5\frac{4}{10}$	0.880	Ditto.

Capt. Morin concludes his account of the valuable experiments made by him, with the following.

General Summary of the Experiments on the useful effect of Turbines.

"From all the experiments that have now been made, which relate,

"I. *To the Turbine of Moussay*, where the height of the fall, during the experiments, was about $24\frac{6}{10}$ feet, and where the wheel was immersed under water about $3\frac{1}{3}$ feet.

"II. *To the Turbine of Müllbach*, where the height of the fall during the experiments, was about 11½ feet, and where the wheel was immersed under water about 2½ feet.

"III. *To the Turbine of Lepine*, where the height of the fall is about 6½ feet.

"IV. *To the Turbine of Inval*, where the height of the available fall was successively reduced from $3\frac{85}{100}$ to $\frac{96}{100}$ feet, whilst on the contrary, the depth to which the wheel was immersed was augmented from 3¾ to 5¾ feet.

"V. *To the Turbine of St. Blaise*, in the Black Forest, where they used a fall of $354\frac{35}{100}$ feet, with a turbine of $1\frac{80}{100}$ feet diameter, making 2300 turns in a minute, and transmitting a power of 40 horses.

We are able to conclude:

"I. That these wheels are equally suitable to the greatest, as to the smallest falls.

"II. That they transmit a net useful effect, equal to 0.70 or 0.78 of the absolute work, or power, expended by the motor.

"III. That they are able to move at velocities extremely distant, more or less, from that which belongs to the maximum effect, without the net useful effect differing notably from this maximum.

"IV. That they are able to do duty under water at depths from 3¼ to 6½ feet, without the ratio of the useful effect to the power, diminishing notably.

"V. That as a consequence of the preceding property, they use all the time, the whole available fall, since we place them below the level of the lowest waters.

"VI. That they are able to receive very variable quantities of water without the ratio of effect to power diminishing notably.

"If we unite to these valuable mechanical properties of the turbines, the advantage that they offer of occupying but little space, of being able, without great expense, and without embarrassment, to be established in such part of the works as we wish, of moving generally at velocities much superior to those of other wheels, thus avoiding gearing or recourse to the transmission of complicated motions, *we conceive, without doubt, that these wheels ought to rank amongst the best hydraulic motors.*"

The striking property which the turbines have of retaining, unimpaired, their co-efficient of effect, or ratio of effect produced, to power expended, even when deeply immersed in *backwater*, deserves further illustration.

Thus from the experiments made upon the powerful turbine at

Inval, which, actuated by a fall of 6½ feet, drives 400 looms at once; it appears that,

With *a fall* of	3¾	feet, and backwater of	3¼	feet, the co-eff.	=	0.77
Ditto.	2	do.	do.	4½	do.	= 0.72
Ditto.	1	do.	do.	5½	do.	= 0.65

And M. Fourneyron, in experimenting upon the turbine of Pont sur l'Ognon, found that with the

Wheel *not* immersed —— and with				$4\frac{3}{10}$	feet fall, co-eff.	= 0.88
Do.	submerged	$1\frac{64}{100}$	do.	$3\frac{4}{10}$	do.	= 0.80
Do.	do.	$0\frac{82}{100}$	do.	$3\frac{4}{10}$	do.	= 0.87

Other experiments might be cited to the same effect, but that it seems unnecessary to add any thing further in order to establish the important fact, *that backwater does not reduce the co-efficient of effect, appertaining to turbine wheels.*

From the experiments of the French gentlemen, of which the mere results have been already quoted, we may with perfect safety conclude; *that for any fall of water whatever, above a yard high, the co-efficient of the net useful effect, returned by turbines, may safely be assumed at three-fourths of the power expended, whether the site be affected by backwater or not.*

Illustrations of the Utility of Turbine Wheels.

When it is recollected that the first turbine was established at Pont sur l'Ognon, in France, in 1827, that descriptions of several turbines, with authentic accounts of their perfect success, were published in Paris, in 1834, and that the conclusive experiments of M. Morin were made public in 1838, it seems really extraordinary that the turbines have not yet been introduced into, or become known, in the United States; whilst reaction wheels, recommended only by a single one of the good properties of the turbine—that of acting well in backwater —have spread rapidly into every quarter of the Union, although they are very far inferior to the turbine, as an hydraulic motor; and being but little cheaper, must ultimately be superseded by the latter, *in all situations where economy of water is an object.*

That such an advantageous motor, should have been so long neglected by the enterprising people of America, is probably owing, in part, to the fact that the record of those experiments, which have so completely established the utility of the turbine, has been locked up from many in a foreign language.*

* We must observe, however, that some unsuccessful attempts have been heretofore made in the Journal of the Franklin Institute, as well as in some of the English periodicals, to draw from the public that attention to the turbine wheels which they really deserve—thus in this journal for 1839, some extracts were given from the report of the French Aca-

Be that as it may, no more time ought to be lost in fairly testing the merits of these wheels upon this side of the Atlantic; for that they richly deserve the closest attention of the proprietors of any works impelled by water power, will appear manifest from a very few remarks.

In the first place, *they are cheap, and being made of cast iron are very durable;* and the writer, from some examination into this question, is inclined to the belief, that even in the first instance, turbines are not likely to be much *more costly* than ordinary wheels of the same power, whilst they will certainly be much more durable, *and therefore ultimately cheaper.*

Turbines compared with Reaction, Undershot, and Breast Wheels.

Whilst the co-efficient of effect uniformly belonging to the turbine, under all circumstances, approximates to 0.800; this value in undershot, reaction, and breast wheels, is only about 0.400 for the two former,* and say 0.500 for the latter when unimpeded by backwater; and hence the great advantage possessed by the turbine as a motor, when compared with these, is strikingly evident, *as it amounts to* 100 *per cent. over the two former, and* 50 *per cent. over the breast wheel.*

Thus if at the numerous reaction, and undershot mills, now in active use in the United States, the present wheels were discarded, and turbines substituted, by that simple act, at a comparatively small expense, *the available power of all such mill sites would actually be doubled!* whilst in many mills a good deal of gearing between the motor and the working point might advantageously be dispensed with. To make this more clear, if we assume that any given reaction, or undershot mill is now making 40 barrels of flour per day, then, by the mere substitution of turbines for the existing wheels, *the same mill could man-*

demy upon M. Morin's experiments; and in 1840 an article on *turbines*, by G. Rennie, Esq., F. R. S., &c., was republished from Herapath's Railway Magazine, London, 1839; notwithstanding this, not much regard seems to have been paid to them, either in this country or in England, up to the present time; but the writer observes, in the late foreign periodicals, that on the presentation of a paper on "Machines recipient of Water Power," by Prof. Gordon, of Glasgow, considerable interest was manifested at a late meeting of the Institute of Civil Engineers, London, and an animated discussion arose, in the course of which, opinions very favourable to the *turbine* were expressed by some distinguished professional men; and hence it is probable that this valuable motor will soon be introduced into England.

* When, in a previous part of this essay, we stated that reaction, flutter, and tub wheels ranked with undershots, and had like them a co-efficient approximating to 0.400; we meant, of course, in case they were working to the best advantage possible; for it is well known to practical men that as they are usually constructed and used, they consume much more water than the best undershot wheels, or have a co efficient *often much less than* 0.400; indeed the undershot wheels themselves seldom realize, in actual practice, more than one-third of the power expended, whilst the other wheels of impulse are generally still less efficient.

ufacture at least 80 *barrels in the same time, and with the same consumption of water.*

Again, wherever breast wheels are now in use, with a fixed amount of water available, 50 per cent. may be added to the power of such mills by employing the turbine and discarding the others; thus for example, let us take the well known breast wheels at Fairmount, which supply the city of Philadelphia with water by pumping it from the Schuylkill into reservoirs 96 feet high, above the surface of the Fairmount pool.

These wheels require an expenditure of about 30 gallons of water falling eight feet, to elevate one gallon 96 feet into the reservoirs; or estimating friction, &c., at one-fifth, they have a co-efficient of near 0.500; now by substituting for these, the turbine wheels which possess a co-efficient of 0.750, only 20 gallons falling eight feet would be expended in forcing one gallon 96 feet high, into the reservoirs; or with the same amount of water as is now used upon the breast wheels, if the pumps were impelled by turbines, and the friction remained constant, they would force into the reservoirs, 50 *per cent. more water.*

In this calculation we suppose that the turbines work with only eight feet fall, which in consequence of the impediment presented to the breast wheels at every tide by backwater, we have assumed as the average effective fall now used; but as the turbines *disregard backwater,* it would be proper in employing them to lay them lower than the breast wheels are now placed—indeed if it were convenient to follow the rule fixed by M. Fourneyron, in the supposed case of placing Turbines at Fairmount, they should be laid "just below the lowest waters of summer," *or in the plane of the lowest spring tide.*

Then in consequence of the phenomena displayed in tidal rivers, showing that the tide rises *very slowly* upon the last of the flood, and falls *very rapidly* upon the first of the ebb; it would be found that with turbines laid below low water mark, an average effective fall of about four feet, out of the common tide of six feet, could be made available; or as the clear fall to common high water is now six feet at Fairmount, we should in this manner acquire a mean effective fall of four feet more, or ten feet in all, by taking proper advantage of the ability of turbines, *to act successfully in backwater;* it is therefore unfortunate that these water wheels were unknown at the time the mill buildings were erected at Fairmount, as it would scarcely be practicable now, to gain the full fall without injury to them.

Upon these data if we calculate the effect produced at Fairmount, in gallons raised into the reservoirs, for every 30 gallons now used on the breast wheels with eight feet virtual fall; or supposed to be used

upon turbines with ten feet effective descent, the following would be the *proximate* results.

With Breast Wheels.	*With Turbines.*
Galls. Ft fall.	Galls. Ft. fall.
30× 8=240 aggregate power	30× 10=300 aggregate power.
Power. Co-eff. of effect.	Power. Co-eff. of effect.
240×0.500=120 useful effect.	300×0.750=225 useful effect.
Deduct friction of the pumps } 1-5th= 24	Deduct friction of the pumps } 1-5th= 45
Galls. lifted 1 foot = 96	Galls. lifted 1 foot = 180
Then 96 ÷ 96 feet height of reservoir,=1 gallon raised 96 feet by the *breast wheels*, for every 30 gallons expended with 8 feet virtual fall.	Then 180÷96 feet height of reservoir,=1¼ gallons raised 96 feet by the *turbines*, for every 30 gallons expended with 10 feet virtual fall.

In fine, if turbines were substituted for breast wheels at Fairmount, and worked with only a little more fall than is now used, they would by the same expenditure of water, *elevate fifty per cent. more.**

But if it were practicable, or convenient, so to locate turbines there, as to avail of 10 feet virtual fall, they would, with the same expense of water, surpass the breast wheels in their work, (though these are well planned and built,) *about eighty-seven per cent.;* and though with the present buildings the necessary arrangements to realize *the full fall* cannot be easily made, still the above calculation demonstrates the vast superiority of this motor for such sites.

As this mode of illustrating the utility of turbines seems to be well suited to the purposes of explanation, the writer will now make a similar reference to the well known water power derived from the Schuylkill river at Manyunk, in this state, and used there upon *overshot wheels.*

Turbines compared with Overshot Wheels.

Although the co-efficient representing the net useful effect capable of being derived from the expenditure of a fixed amount of water, upon overshot and turbine wheels *is identical,* or approximates to 0.800 in both; still the latter are superior as general motors, owing to

* As the day is not far distant when the amount of water required to feed the breast wheels and their pumps, which now supply the city of Philadelphia with water for use, will equal in quantity the entire summer flow of the Schuylkill river—clear of the leakage of Fairmount dam, and of the amount necessary for the navigation—it must be a gratifying reflection to the citizens that when that day does come, all that they have to do is to resort to the use of the beautiful invention of M. Fourneyron, discard all the breast wheels, and substitute turbines in their stead, *whereby their supply of water will be at once augmented at least one half;* and a resort to auxiliary works at Flat Rock, which have been projected in advance by the able and experienced superintendent of the water works, may thus be postponed for another generation, if not entirely relinquished.

their ability to use, *or make available, the allowance often made for backwater,* and also to dispense with a great deal of gearing.

Thus at Manyunk, where the head and fall is near 23 feet at ordinary times, it has been deemed advisable, (judiciously without doubt) to throw off, in setting the wheels, *two and a half feet of the fall as an allowance for backwater;* and to employ overshot wheels of but about 17½ feet average diameter, working under three feet head; hence the head and fall actually employed is only 20½ feet; now if turbines were used at that place in lieu of overshot wheels, the backwater might safely be *disregarded,* and thus the entire fall of 23 feet would be made useful, *or about one-eighth would be added to the power of the mills established at Manyunk.*

Advantages similar to those we have recited, have resulted abroad from the employment of turbines in lieu of other wheels, and such a course will be the result here, for it must be particularly remarked that the turbine wheel is not a merely speculative or untried project, *but a thoroughly tested and proved machine, about the utility of which, upon the largest scale which practice requires, not the shadow of a doubt can remain upon the minds of any who choose to investigate the subject.*

The turbine wheels possess another prominent advantage which we will now briefly illustrate; thus upon a 23 feet fall such as that at Manyunk, an overshot wheel of 20 feet in diameter, if running at its best velocity of six feet per second at the skirt, would make but six turns in a minute, whilst a millstone, for example, must run about 120 revolutions in that time; hence, such an overshot wheel, if applied to a flour mill, would require gearing in the ratio of 20 to 1, between the motor and working point; but if the turbine were used in such a place under 23 feet fall, it would, when working at its maximum rate of effect, run at least 175 revolutions in a minute, *requiring no gearing whatever to get up the speed desired;* consequently a considerable saving would ensue from dispensing with the spur gear, whilst at the same time the power consumed in driving this gearing (which is frequently great) would be saved or reserved for direct application to the work.

In conclusion, the chief points of advantage promised by the use of turbines upon the millseats of the United States, may be briefly summed up as follows.

1. They act with perfect success in backwater.
2. They are not liable to obstruction from ice.
3. They require but little gearing to get up a high velocity at the working point.
4. They use to advantage every inch of fall.

5. They are equally applicable to very high and very low falls.
6. They are equal in power to the best overshot wheels.
7. They may vary greatly in velocity without losing power.
8. They are very compact, and occupy but little room.
9. They may be very accurately regulated, to an uniform speed, by means of a governor connected with the annular sluice gate.
10. They are perfectly simple and not likely to get out of order.
11. They are not very expensive.
12. They are very durable.

These, it seems to the writer, are twelve good reasons, for the adoption of turbines as the motors in all future mills erected in this country —indeed they would fully justify the substitution of them in place of most of the wheels now in use upon our mill seats; for either upon one account or another, the turbine is superior to all other water wheels, *and consequently must be regarded as the very best hydraulic motor now known to mechanics.*

Philadelphia, Sept. 1, 1842.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Cost of Transportation on Railroads. *By* C. Ellet, Jr., C. E.

[CONTINUED FROM PAGE 233.]

On the Relative Values of Distances and Gradients.

In the preceding numbers I have offered convenient and appropriate formulas for computing the cost of transportation on railroads, and determining the effect produced on that cost by variations in the acclivity of the limiting gradients. I propose now to ascertain the value of any increase or diminution of the length of the line in terms of that grade; that is to say, to determine how many feet per mile the steepness of the limiting gradient may be increased for the purpose of saving one mile of distance; or what increase of distance will be justifiable in the development of a road for the purpose of reducing the line to a level, or of saving any given amount in the rate of ascent of the limiting gradient.

For this purpose we will recur to our formula (B), which expresses the annual charges of the company, and write it thus—

$$\left(2\,C\,\frac{20+x'}{20\,W}\,t' + c\,t'' + \frac{14\,t}{1000} + 500\right)h;$$

in which x' is put for the empirical, or accidental grade, in feet per mile, which it is desirable to relieve; t' the number of tons gross which annually ascend that grade in full trains; t the number of tons net annually transported through the line, in both directions and in full

trains; t'' the number of tons gross carried through the line; C the cost of running a freight engine with its tender one mile; c the additional cost of locomotive power for each gross ton carried one mile, and h the length of the road in miles.

It will, of course, be observed that this formula is applicable only to roads which are used exclusively for the conveyance of freight, and is obtained in the supposition that all the engines are loaded to their maximum capacity on the limiting gradient. But in all lines used for general travel, the passenger trains, at least, and sometimes a portion of the freight trains, are much lighter than the engine is capable of conveying on this grade.

In order, therefore, to express correctly the aggregate annual expenses, *on such lines*, and to render the equation, which it is proposed to deduce, as general as possible, we must add to the above formula the cost of motive power for the number of miles traveled by the engines which are not fully loaded, and the expenses incident to the conveyance of the whole number of through passengers, which are not covered by the cost of power. These expenses have already been stated to be $\frac{p\,h}{100}$, where p represents the number of passengers carried "through;" and if we represent by N' the number of trips made by engines carrying passengers and less than their full compliment of freight, and by C' the cost of running such engines with their tenders one mile, the expression of the aggregate annual expenses, in its most general form, will become

$$\left(\mathrm{C'\,N'} + 2\,\mathrm{C}\,\frac{20 + x'}{20\,\mathrm{W}}\,t' + c\,t'' + \frac{14\,t}{1000} + \frac{p}{100} + 500\right)h; \quad \text{(G)}$$

in which only one of the terms is affected by the value of the grade.

This is a modification of the approximate formula (A), given in a previous number, and is expressed in different terms, though it yields very similar results.

By means of this expression we may readily compare the merits of two lines, of different lengths and grades, and accommodating the same, or different amounts of tonnage, and determine the difference between their values. For this purpose we have only to substitute for the notation the actual values of the gradients, and the lengths of the two lines, and calculate by the equation the annual charges which they respectively involve.

It was from this expression in the simpler state in which it may be presented for application to a road on which the business is restricted exclusively to the transportation of freight, that we determined, in the

preceding number, the sum which might, with propriety, be expended for the reduction of the limiting gradient. But we are not to regard that expression as authorizing a diminution of the acclivity of the gradient, at the expense of any augmentation of distance, unless the value of the increase of the distance be taken into the account. Any increase of the length of the line of the improvement necessarily involves an increase of expense for its maintenance; for the locomotive power which traverses it, and for the cars which pass over the additional distance. The value of this increase of the annual charges consequent on any augmentation $h'—h$ is obviously

$$\left(C' N' + 2 C \frac{20 + x'}{20 W} t' + c t'' + \frac{14 t}{1000} + \frac{p}{100} + 500\right)(h'—h); \quad \text{(H)}$$

an expression from which we are able to calculate immediately the annual value of any augmentation or reduction of the length of the road, and consequently the sum which it would be expedient to expend for the purpose of effecting any given reduction.

But we have already seen that if we diminish the inclination of the maximum gradient any quantity $x'—x$ feet per mile, we simultaneously reduce the aggregate annual expenses the amount represented by the expression

$$2 C \frac{x' — x}{20 W} t' h.$$

In order, then, to determine the change in the length of the line which will have the same effect on the cost of transportation as any given reduction of the limiting gradient, we must equate these two quantities, and deduce from the equation the value of distance, or $h'—h$ in terms of the change of gradient. This operation produces for the expression of the quantity which we will be authorized to increase the length of a road for the purpose of reducing the limiting gradient, of which the ascent is x' feet per mile, down to any other rate x feet per mile,

$$\frac{C}{10 W} \cdot \frac{h t' (x' — x)}{C' N' + 2 C \frac{20 + x'}{20 W} t' + c t'' + \frac{14 t}{1000} + \frac{p}{100} + 500} = h'—h. \quad \text{(I)}$$

The augmentation of the length of the road adequate to compensate for any given reduction of the limiting grade, is therefore directly proportional to the original length, and reciprocally, or very nearly so, as the power of the engines used in the conveyance of the freight. The greater the tonnage which ascends the limiting gradient, the

greater is the distance that the length of the line may be increased in order to reduce that gradient any given amount per mile; and the greater the power of the engine kept in operation at a given expense per mile run, the less would be the increase of the length of the road for the same purpose. The greater the number of passengers that are carried in light trains, and the greater the proportion of the tonnage which is conveyed by engines loaded below the maximum due to the limiting grade, the shorter must be the line and the steeper the grades. The measure of all these influences is deducible from the formula, which I regard as the true equation of distance. It is expressed in as accurate terms as it is practicable to obtain with our present experience. In course of time the co-efficients may, perhaps, be advantageously modified, to suit the more precise determination of the value of railway constants, which we may anticipate from the increasing facilities which are offered, and the more accurate observations which such facilities will permit.

In order to apply the formulas, we must determine the values of C, C' and *c*. Of the two first, C may be estimated, in ordinary cases, at three-tenths of a dollar, and C' at a quarter of a dollar; and experiment will justify the assumption of a half mill per mile for the average increase of the cost of motive power, due to each gross ton added to the load of the engine—a fact which is expressed by the equation $c = \frac{1}{2000}$ of a dollar. In the formula t'' is put for the gross tonnage of the line, consisting of passengers and freight and the cars which contain both, whether attached to engines conveying full or partial loads.

Let us take the following case for an example. The length of the road, by the preliminary survey, is 30 miles; the limit grade which the eye and judgment have established on the profile, is 40 feet per mile; the anticipated freight is 60,000 tons net, and is likely to be so divided in direction that there will be found an annual gross weight of 40,000 tons ascending this limit grade. The tonnage trains are supposed to be full, and the gross weight of cars, freight and passengers is 130,000 tons. The number of through passengers is 20,000, and the power of the engines intended to be used is adequate to the command of 300 tons gross on a level road. Now,

I. How much would it be good policy to expend in the construction of this road in order to reduce the grade which limits the load from 40 feet down to 30 feet per mile?

II. How much could we afford to pay for the reduction of the length of the road one mile?

III. How much would we be authorized to increase the length of

the road in order to reduce the rate of ascent of the limit grade ten feet per mile?

IV. How much would we be authorized to increase the length of the same road in order to reduce the limit grade ten feet per mile, in the supposition that no passengers are to be conveyed, and that the gross tonnage is all conveyed in full trains, and amounts, exclusive of passengers and their baggage, to 120,000 tons?

Now we have $C' = \frac{1}{4}$; $C = \frac{3}{10}$; $c = \frac{1}{2000}$; $t = 60{,}000$; $t' = 40{,}000$; $t'' = 130{,}000$, and for the fourth problem 120,000; $p = 20{,}000$; $h = 30$; $x' = 40$; $x = 30$, and $W = 300$.

The appropriate quantities being substituted in equation (F) will give, in answer to the first problem,

$$\frac{40{,}000 \times 30 \times (40 - 30)}{600} = \$\,20{,}000:$$

or, it would be worth while to expend 20,000 dollars in grading the road to reduce the ascent of this limiting slope ten feet per mile, providing we do not thereby incur any increase of the cost of maintenance, or any augmentation of distance.

Again, by inserting the values provided by our data in equation (H) we obtain, for the solution of the second problem, in the supposition that the passenger trains make two trips a day, or that $N' = 730$

$$\frac{730}{4} + \frac{3}{5} \cdot \frac{20+40}{20 \times 300} \times 40{,}000 + \frac{130{,}000}{2{,}000} + \frac{14 \times 60{,}000}{1{,}000} + \frac{20{,}000}{100} + 500 =$$

2,027 dollars, for the annual charge incident to each mile of the length of this particular road. We multiply this quantity by $\frac{100}{6}$ to obtain the equivalent capital, which we find to be $\$\,33{,}783$.

It would be worth about $\$\,34{,}000$ to reduce the length of this road one mile.

Again, by inserting these values in equation (I) we will obtain in solution of the third problem

$$\frac{\frac{3}{10} \times 30 \times 40{,}000\,(40 - 30)}{3000\left(\frac{730}{4} + \frac{3}{5} \cdot \frac{20+40}{20 \times 300} \times 40{,}000 + \frac{130{,}000}{2{,}000} + \frac{14 \times 60{,}000}{1{,}000} + \frac{20{,}000}{100} + 500\right)} = \frac{1200}{2027}$$

or about *four-sevenths of a mile.* On such a road, the value of ten feet in the limiting grade is only equal to four-sevenths of a mile in distance, although that grade is not opposed to the heavy trade—a fact which should prompt us to be on our guard when we attempt to reduce the grades of a road by an increase of distance before we have

examined well into the character and amount of the trade which is to be accommodated.

Finally, we shall have, for the solution of the fourth problem,

$$\frac{\frac{3}{16} \times 30 \times 40{,}000\ (40-30)}{3000\left(\frac{3}{5}\ \frac{20+40}{20\times 300} \times 40{,}000 + \frac{120{,}000}{2{,}000} + \frac{14 \times 60{,}000}{1{,}000} + 500\right)} = \frac{40}{55}$$

or about *five-sevenths of a mile:*—showing that we can increase the length of this road 25 per cent. more, for the purpose of reducing the grade any given amount when we carry no passengers, although the amount of freight is the same, than when the road is destined, in part, for the accommodation of travel. This is simply to say that the value of distance increases with the increase of every part of the business of the line; while the value of a gradient increases only with that portion of the business which ascends it in full trains.

It may be objected to the method which is here pursued that the calculations are predicated on data which are exceedingly difficult, if not impossible, to procure, in anticipation of the experimental result. It is certainly true that such inquiries are not free from some difficulty and uncertainty; and it is also true that the engineer must overcome this difficulty or proceed to his work entirely at random. The values of grades and distances turn upon these facts, and they must either be regulated without regard to any principle, or by these, or some similar equations. The application of the equations will, of course, be somewhat inconvenient, since they compel us to know something about the thing we are doing; they compel us, when we propose to cut down a hill or fill up a hollow, to know what it is to be done for, and to judge how much we shall cut, and when we shall stop. But, however inconvenient it may be to answer such inquiries, it is not the less important to study the subject, and learn how to answer them by some better mode than mere conjecture.

It is unnecessary to make additional application of the formulæ. They are remarkably simple and obvious, and by supplying a ready and convenient mode of comparing different lines, or different locations of the same line, they remove many of the difficulties with which every engineer must have felt himself embarrassed in the exploration or establishment of important improvements. They indicate the proper and only convenient general mode of estimating the aggregate cost of transportation under different assumed quantities of tonnage; and teach us, in the location of a line, the correct value of distance—in the calculation of which the cost of freight is the essential element—and at the same time enable us so to regulate the grades that the transportation may not be improperly embarrassed, and that the com-

pany may not be induced to pay more for the reduction of the cost of freight than the reduction is worth. These are all matters of great interest, and questions which can never be overlooked by an engineer who faithfully performs his duty. Indeed, they must all be met, and maturely considered, at every step of his progress, or the work which is placed under his professional charge will be found to be a failure, and in all probability soon pass into the hands of assignees, or come under the hammer of the Sheriff. They are always objects of immense consequence in the decision of the great questions of general location, which arise in determining the proper routes for railroads of great extent, passing through districts where different lines, having various pretentions, are presented, and where the comparisons of distances, grades, and elevations are of constant occurrence. They are also important where no such general choice is presented, in determining on the details of the location of every line. A road is scarcely ever surveyed on which there is not found some one gradient which controls the average load of the engine, and which it is desirable to reduce.

The first point to be determined, in all such cases, is the probable amount of trade to be transported. This is the leading fact which should govern all the arrangements which are to be made with a view to its accommodation; and the one which has probably elicited the least attention of all in the construction of the railroads, great or small, of this country. There are some lines which were apparently intended for the accommodation of immense quantities of freight, in the design for which no computation was ever instituted for the purpose of ascertaining the probable amount of the trade, or the sum which that quantity would authorize the company to expend for the purpose of removing given obstructions; and there are others on which the actual tonnage is so small that the directors have yet been ashamed to name it to the public, although, in the construction of their road, they permitted arrangements to be made for its accommodation, on a scale of magnificence which could hardly have been justified in anticipation of the trade of India. More labour has been expended in the transportation of materials for the construction of many roads than would have been required to effect the transportation without them of all the tonnage which they are destined to transmit, for all time to come.

There is, accordingly, no return received for the absorbed capital; these works are failures, and they have failed in consequence of the disrespect of the parties by whom they were destroyed, of the first principles which should control every application of machinery to economical purposes—viz. *to make the power proportional to the duty to be performed—and to expend no more money for any object than the value of the object will warrant.* Had this simple maxim

been kept constantly in view in the prosecution of the enterprises which, in this country, have characterized the last twelve years—and been made the test of every plan and every arrangement—there would have been no ruined companies, no railroad auctions, and probably no failures.

In discussing the important questions incident to this subject, the object has been to obtain fair average values of the points at issue, and to deliver the results of the investigation as free from algebraical expressions as is consistent with the necessary accuracy. In this view several quantities, of subordinate consequence, have been overlooked, and the investigation is made to turn upon the essential considerations which rule the result. And this is sufficient; for it is in vain to hope for the attainment of perfect accuracy in questions of this nature, where much uncertainty always prevails in the determination of the value of the data; and the solution which comes within 10 or 15 per cent. of the truth possesses all the accuracy that is necessary to insure the requisite confidence. It is not to *such* errors that companies may trace their destruction; but to the utter and entire disregard of all the essential quantities, circumstances, and considerations, on which success was dependent.

The ruling fact, which ought to control every movement and every plan, is the number of tons to be conveyed one mile. This quantity is made up of the absolute tonnage and the length of the line. If a locomotive engine of 50 horses power be capable of conveying the daily trade on a road 50 miles long, it follows that an engine of five horses power will be adequate to the conveyance of the same tonnage on a road five miles long. And if an engine of 50, or any other number of horses power is able to accomplish the whole labour required on the first road, the same engine will be occupied but *one hour out of ten* in doing the work of the second road. The shorter road, therefore, requires less power—engines of less weight—rails consequently of less strength—and admits, as we have seen, of steeper grades.

In short, *the number of tons to be carried, and the distance which it is to be carried, control the grades, establish the location, and determine the power; the power required fixes the weight of the engine which supplies it; the weight of the engine rules the strength of the rail by which it is supported, and the strength of the rail limits the weight of the car and its load.*

There are certain obvious relations between the duty to be performed by the road and the capacity of the improvement, and the power of the machinery to be applied on it; and if these relations be not respected, both in the general design, and in all the detail, it can only be by sheer accident that the enterprise is successful.

[TO BE CONTINUED.]

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Memoir Descriptive of the Explosion of the Boiler of the Steamboat Medora, in the port of Baltimore, in 1842; embodying all the leading facts which could be collected on the spot, and accompanied by some suggestions concerning the general construction and management of Steam Boilers. *By* BENJAMIN H. LATROBE, Civil Engineer.

TO THE COMMITTEE ON PUBLICATION:

Gentlemen,—I regret that several causes have concurred to make the memoir of the explosion of the "Medora," requested of me in your letter of April 27th, and promised by me through my friend Mr. E. Morris, so late in its forthcoming, especially as I find that it must be, after all, but a brief sketch of the disaster. I have been unable to gather much other testimony than that which has appeared in the papers; most of which is but little to be relied on, coming, as it did, from witnesses either interested in disguising the truth, or incapacitated by the awful circumstances of the accident, from correct observations, or relation of the facts. The history of the occurrence is shortly as follows.

Upon the 14th of April, 1842, the Medora, a new steamboat, built by a company, to run between Baltimore and Norfolk, was prepared for a trial trip down the Patapsco. She lay at the engine builder's (John Watchman) wharf, on the south side of the Basin. Her fire was lighted at about 2 o'clock P. M., and about an hour after, the agent and some of the proprietors came on board, and she prepared to start. There were probably between 50 and 100 persons in her when she started, many of whom were workmen connected with her construction, and, as on such occasions, these persons, each deeming himself to be "magna pars" of the affair, are prone to intermeddle; there was much crowding and confusion about the engine, and its proper management by the engineman was not unlikely to be interfered with. The pride of the workmen in the expected performance of the boat would naturally dispose them to do all they could to accelerate her speed, and the suspicion afterwards expressed, that undue means were employed to increase the pressure of the steam, was not unreasonable. It has also, indeed, been supported by sufficient testimony; though at the same time contradicted, I am told, by one of the surviving witnesses of the calamity.

The boat had just cast off her lines, and in backing out, had made one or two revolutions of her wheels, when her boiler burst. Five and twenty persons on board, were killed or mortally wounded; the

upper, or promenade, deck over the boiler, was blown in fragments into the air, and the forward part of the hull so shattered that she immediately sunk in ten or twelve feet water. Her engine, except in its connexion with the boiler, and the after part of the hull, was uninjured. The accompanying drawings, by their dotted lines and shaded parts, exhibit the form and position of the boiler before and after the explosion. It was placed forward of the wheel houses, standing fore and aft, in the hold of the vessel, and rising up through the main to within three or four feet of the upper deck. The boiler was thrown upwards to the height of the top of the engine beam, or more than thirty feet, and, while in the air, it turned, so as to fall upon its side, exactly crosswise of the boat. Circumstances connected with the escape of the steam and water, and the resistance of the wood work of the upper deck, no doubt caused this singular rotation.

The boiler, (see figs. 1 to 5, Plate I,) consists of a cylinder eleven feet in diameter, and nineteen feet long, supported on three legs, A, B, C, of the same horizontal length, and composed of sheets five and a quarter inches apart, connected, as usual, by staybolts. The side legs, A and C, are about seven feet, and the middle leg, B, two and a half feet high. To admit the water into these legs, the cylinder, or belly, of the boiler is cut away by rectangular apertures at frequent intervals. The lower half of the cylinder is occupied by forty-seven tubes, eight inches in diameter, through which the smoke and flame are returned forwards, from the chamber at the back of the boiler, towards the chimney in front. Between and above the rows of tubes, were round tie rods three-fourths of an inch diameter; horizontal and crosswise to the cylinder, but similar rods could not be introduced vertically between the tubes on account of the spaces between them not coming in a line over each other. Thus the top and bottom of the cylinder were not stayed by direct ties connecting them in the position of chords—but the top angles at either end of the boiler were braced by diagonal bars and rods, as shown by fig. 5, and above the tubes were one or two rows of longitudinal rods of one inch diameter, going from the forward to the after head. The sheets of the boiler were of the *usual* thickness of one-quarter of an inch, and do not appear to have been of bad quality. There were two fire doors in front, for the introduction of the fuel into the spaces between the legs, see fig. 4; and in the sheet iron composing the front of the smoke chamber supporting the chimney stack, there was a small, movable, circular door opposite each tube, for the insertion of an instrument to clean the flues, when required. The number of gauge cocks was *four*, the lowest being a little above the level of the highest row of tubes. The safety

valve was placed upon a drum near the top of the boiler, and was, as will be seen hereafter, of large dimensions.

Such was the boiler in all its parts; and its unusual size and bold design, must be striking to every observer.

An examination of the wreck of the boiler, as it still stands in the yard of Mr. Chas. Reeder, engine builder, and as it is correctly exhibited in the several views presented in the drawings, clearly shows that it first gave way where the legs unite with the belly, and where the removal of so much of the metal reduced the strength of the cylinder to its minimum. The explosion was *downwards*, carrying away the right hand or starboard leg, and the middle one (see figs. 3 and 4,) and tearing into shreads the inner sheet of the larboard leg, (see fig. 5,) at its junction with the cylinder. The escape of the steam and water, principally on the starboard side, probably caused that side to revolve vertically in the rise of the boiler into the air, and thus would have made it fall upon its larboard side in the descent, while at the same time a horizontal revolution was effected by the forward rush of the expelled fluid towards the angle made by the front and starboard side, this part of the front appearing to be pushed outwards. The boiler evidently fell first upon the hind and upper larboard corner, which is seen to be much crushed, while the explosion operated most powerfully on the front and lower starboard corner. These two corners are diagonally opposite to each other, and this circumstance may account (in connection with the entanglement of the boiler in the fragments of the upper deck,) for the rotation. As the boiler lay in the hold on its larboard side after the explosion, the starboard and middle legs, together with the portions of the cylinder between them, were not entirely detached, but were so far bent backwards, and curled over, as to embrace the circular top, and previous to the raising of the boiler out of the sunken hull of the vessel, they had to be separated by the chisel along the ragged lines *f*, *g*, (fig. 3.) The cutting of the apertures over the legs, in the manufacture of the boiler, to admit the water into them, left the segments of the cylinder, between the legs, united only by the strips of sheet metal remaining, and of these strips, as seen in figs. 3 and 5, not more than one half the original number are left, the rest being carried away by the explosion. The other injuries received were partly due to the rupture and partly to the fall of the boiler, and the numerous and extensive rents manifest the insufficiency of the opening first made, though large, to vent the confined fluid, and that the destruction once begun proceeds, ad libitum, as in almost all similar cases.

Description of the Drawings, which exhibit various views of the Boiler of the Medora after its explosion.

The drawings from 1 to 5, inclusive, are by a scale of four feet to the inch.

Fig. 1 is a view of the *larboard side* of the boiler.

a, the *four* gauge cocks.

b and *c*, rents in the side of the boiler, where the rivets are torn out.

d, *d*, *d*, other rents.

e, place of the safety valve.

f, corner upon which the boiler pitched after being projected in the air by the explosion; and within the crumplings of the iron at this corner, a piece of timber, torn from the deck, was still inclosed, when this drawing was made.

Fig. 2 is a view of the *back* of the boiler.

a, the man hole.

b, *b*, *b*, holes left by fragments blown out in the explosion.

Fig. 3 is a view of the *starboard side* of the boiler.

a, *a*, holes cut by a chisel.

Fig. 4 is a view of the *front* of the boiler.

d, *d*, the fire doors for the admission of fuel.

The 13 tube holes shaded darkest have their tubes still in them, the remaining tubes have been removed since the explosion, but were uninjured by it.

Fig. 5 is a *vertical section* through the length of the boiler; the dotted lines, in this and fig. 2, showing the original outline of the boiler, the water legs, &c.

a, the back smoke box.

b, the front ditto.

Fig. 6 is a *general sectional view*, showing the position of *the boiler* and of the chief parts of the machinery. Drawn by a scale of 30 feet to the inch.

The construction of the boiler, and the manner of its destruction, having been thus described, I proceed to estimate its strength from the data I have procured, together, and in comparison, with the probable pressure of the steam at or near the time of the explosion, and to state the facts of which I received information, respecting some of the circumstances of the accident, accompanied by such remarks as have suggested themselves to me in regard to its causes and effects.

The weakest part of the boiler, to which the calculation must evidently be applied, was manifestly the part of the cylinder immediately over the legs, where the continuity of the sheets was interrupted by

the apertures made in them to let the water down into the legs and promote its circulation throughout the vessel. One half of the strips of iron left between these apertures has been carried away, and the measured width of those that remained is irregular; but there is enough to show that the united breadth of all the strips did not exceed that of the spaces between them, so that the boiler was not more than half as strong over the legs as elsewhere, ceteris paribus. Thus in every twelve inches of the length of the cylinder there were but six inches of sheet iron to unite the segments separated by the legs. A further reduction of strength in the connection of these segments was again made by the occurrence of seams in the strips, depending on rivets, and weakened by the holes punched for their insertion. Now the strength of a joint of this kind will depend upon the resistance of the rivets, and also on that of the remaining iron of the plates which they unite; which resistances should manifestly balance each other, to give the maximum of strength to the joint. The plates may be separated in three ways. 1st, by cutting off, or tearing asunder the rivets, or tearing off their heads. 2nd, by splitting and tearing out the metal between the rivet holes and the edge of the sheet. 3rd, by tearing off the sheet iron between the holes, and in a line with their centres. That it may be indifferent, so far as dimensions are concerned, in which of these three ways the joint may separate, there must be certain fixed proportions between the diameter of the rivet, (the head of which we will suppose to have always such an excess of strength as to make the shank of it give way first,) the clear distance between the rivet holes and the edge of the plate, and the clear distance between the holes themselves, the thickness of the sheet being of course a constant element. Let us now see whether, in the riveting of the sheets of this boiler, the correct proportions were observed—1st, the rivets are eleven-sixteenths of an inch in diameter, and each has a transverse sectional area of 0.375 of a square inch, and, there being three rivets to every *strip* of six inches wide, the whole area of the rivets will be 1.125 square inches. 2nd, the line of metal left between the holes will be $(6 - 2.062) = 3.938$ inches wide, which multiplied by one-fourth of an inch, (the thickness of the sheet,) will give an area of 0.985 of a square inch. 3rd, the clear distance of the holes from the edge of the sheet, is one and a quarter inch, which, multiplied by one-fourth of an inch, gives an area of 0.312 of a square inch and for the three holes a total area of 0.936 of a square inch. The three resistances appear thus to be somewhat unequal, that of the rivets being the greatest by 14 per cent. of the strength of the metal between the holes, and 20 per cent. of that of the metal between the holes and the edge of the sheet. But when it is recollected that in the first case

Fig. 1.

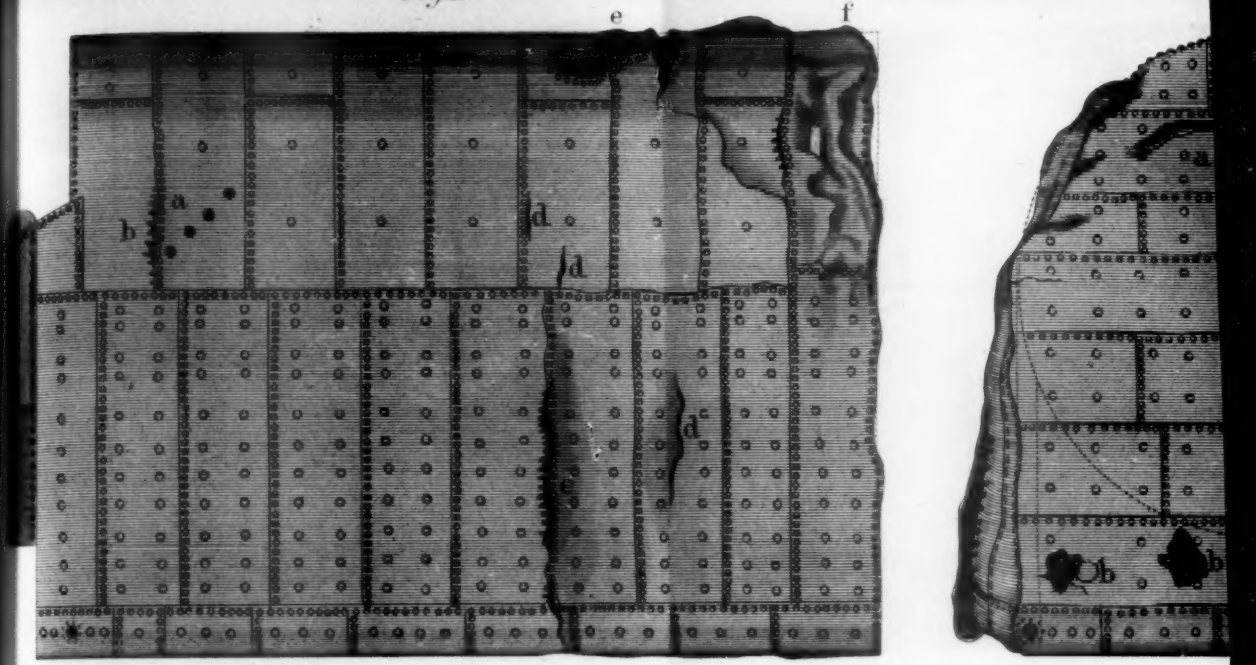
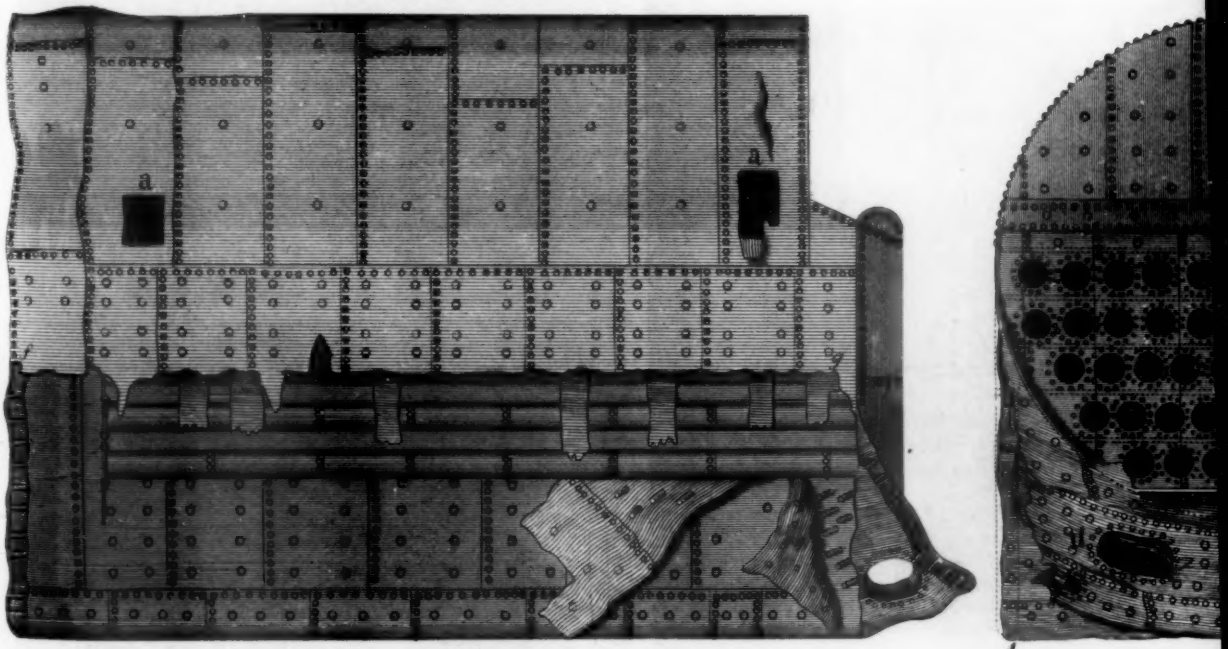
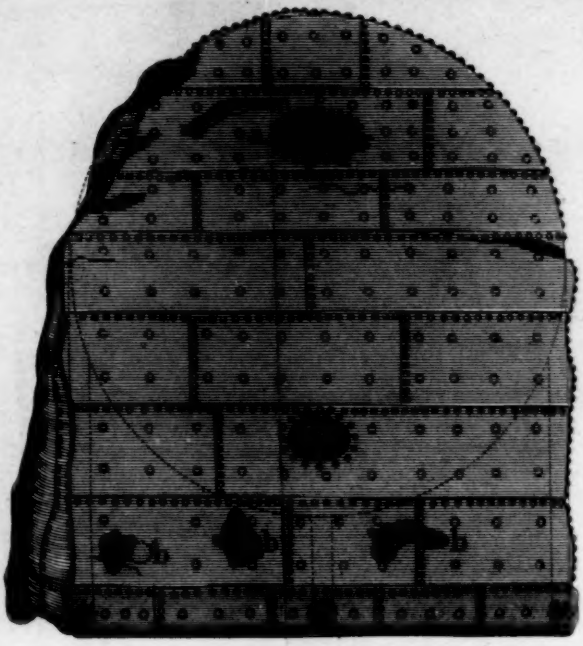


Fig. 3.





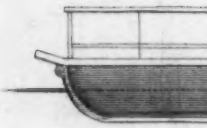
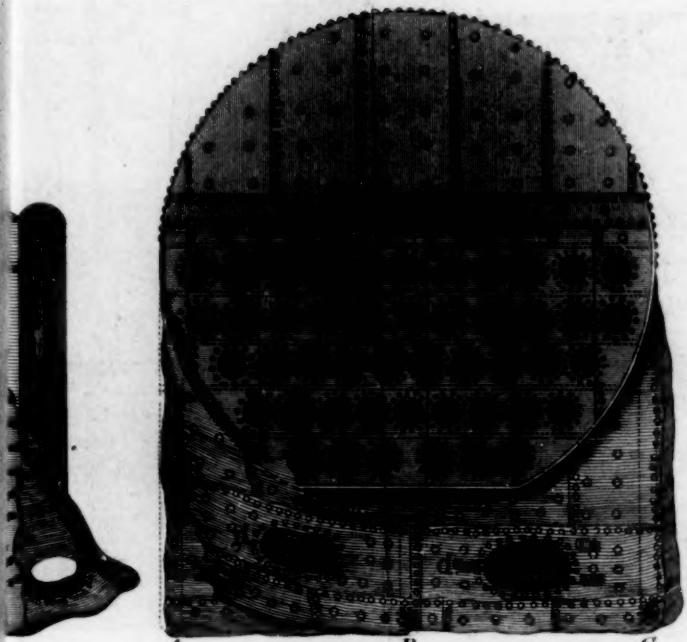


Fig. 4.



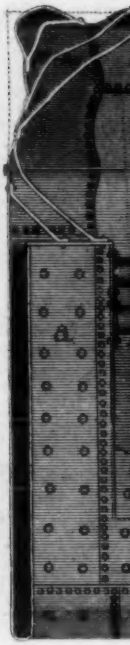
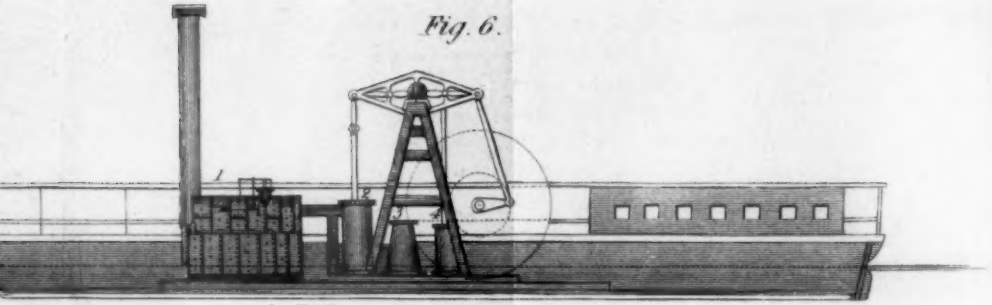
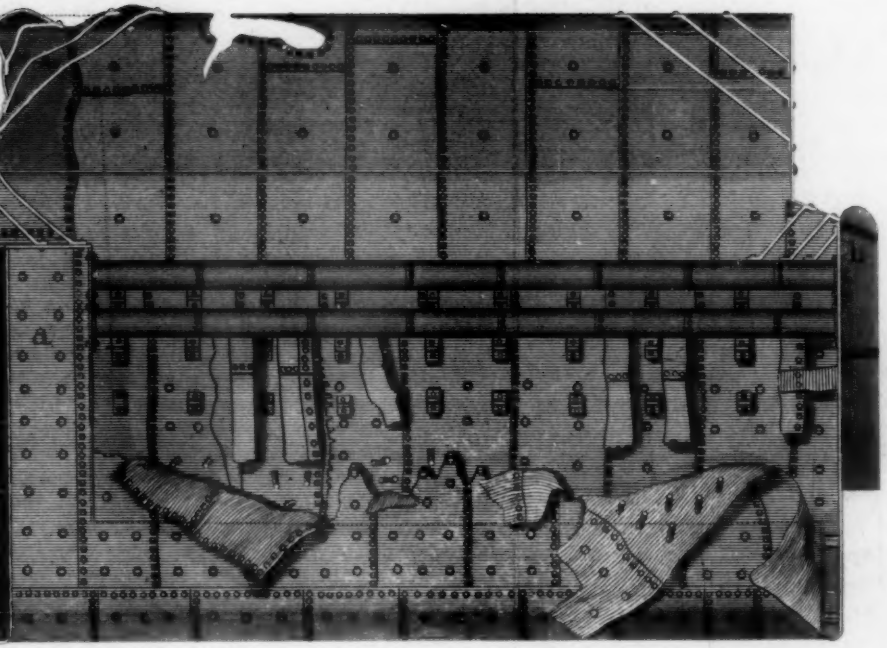


Fig. 6.



1.- Boiler
2.- Cylinder.
3.- Condenser.
4.- Air pump.

Fig. 5.



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the rivet loses part of its whole strength by the strain it suffers in cooling, after being headed in a heated state, and that in the third case the tearing out of the metal involves more than the mere separation of the area of resistance, inasmuch as to permit this, the metal must be considerably bent on either side of the line of rupture through which the rivet makes its way out, and as furthermore, the *friction* of the lapping surfaces of the plates augments their opposition to a separation by sliding on each other, it would seem as if the three resistances were very near to a practical equality, and that the sizes, numbers, and positions of the rivet holes were about what they should be, for the required equilibrium between the parts of the joint. Other boilers which I have examined show a similar adjustment of parts in the joints, so that general practice would seem to accord with the conclusions of the present calculations. An inspection of the manner in which the plates of the Medora's boiler separated at the seams, showed that, in most instances, the metal between the rivet holes and the edge of the sheets, gave way by tearing out, leaving the rivets and intermediate metal uninjured, and this consists with the preceding estimate which makes this element of the joint the weakest of the three. Inasmuch, however, as they approach so nearly an equality of strength, and each may occasionally give way before the others, it may be as well to take the *average* of their resistances for an expression of the strength of the joint, and this should be $\frac{1.125 \times 0.925 + 0.936}{3} =$ 1.015, or say one square inch of metal for every twelve inches (six inches of strip and six inches of space) in the length of the boiler, one-twelfth of a square inch, per running inch of the same; and this is the measure of the strength of that part of it over the legs. Now the elements of the calculation to determine the strain that a cylindrical vessel will bear, from the outward pressure of an elastic fluid, consists of the diameter of the cylinder, the thickness of the material composing it, and the modulus of the strength of that material. Thus if D be the diameter of the cylinder, t the thickness of the iron (both in inches,) P the average force in pounds that will tear asunder a square inch of boiler iron, and x the steam pressure per square inch on the boiler sufficient to burst it, we have the equation $D\,x = 2\,P\,t$, where $x = \frac{2\,P\,t}{D}$. Now D = 132 inches—P = 55,000 lbs. $t = \frac{1}{4}$ of an inch. Consequently $x = 208\frac{1}{3}$ lbs. which would be the pressure of the steam per square inch required to burst the boiler, if it were a continuous hollow cylinder without seams or joints to reduce the quantity and resistance of the metal composing it. But this is not the case in any boiler. The joinings if the plates, if there were no holes

in the boiler, would necessarily reduce the strength to about two-thirds of the entire strength of the sheets, were it not for the support they yield each other at the *laps*, where they are doubled upon each other. In the Medora's boiler, it is seen above, that for every twelve inches in the length of the cylinder over each leg, there is but one square inch of metal resisting rupture, instead of three square inches, which there would be if there were no rivet holes, or spaces, between the strips of iron. So the strength of the boiler over the legs is reduced to the one-third of its full strength in other places, where there are no seams, or perforations; consequently, we must divide the value of x, as above obtained, by 3, to get the real pressure, per square inch, that the boiler was capable of sustaining. Then $\frac{208-33}{3} = 69.44$ pounds per square inch, the utmost strain that this boiler could have borne, without giving way at this, the weakest place. The pressure here spoken of, is of course the *effective* pressure, or the excess of that of the steam over that of the atmosphere.

Let us now proceed to estimate the pressure which could have been produced upon the boiler of the Medora by loading the safety valve to the utmost with the weights which were *attached* to it, and intended so to be used, when occasion should require the maximum pressure, considered by the engine builder to be safe. The diameter of the valve was 15¼ inches at the bottom, with a mitre of 1¾ inches, making its top diameter 17 inches. The levers of the valve were of the second order, and two in number. The primary lever, operating immediately on the valve, had a total length of 35 inches, and from the fulcrum to the centre of the valve disk, was 12½ inches, making a ratio of $\frac{1}{2.8}$. The secondary lever, operating on the end of the primary one, had a total length of 67 inches, and from the rod connecting the two, to the fulcrum of the former, the distance was 10 inches. There were two weights, of cast iron, on the secondary lever, the largest, nearest to the end of it, weighing (by estimate) 200 pounds, and the smaller 56 pounds. When these two weights, which slid as usual on the arm of the lever, which they were perforated to receive, were in contact, and pushed out to the end of the lever, the distance of their centre of gravity from the fulcrum of the long lever, would be 57 $\frac{6}{10}$ inches; so that the ratio of this lever would be $\frac{1}{5.76}$ and the ratio compounded of those of the two levers $\frac{1}{5.76} \times \frac{1}{2.8} = \frac{1}{16.128}$.

If the area of the valve be calculated, from its mean diameter,—viz: $\frac{15.25+17}{2} = 16\frac{1}{8}$, it will be found $= 204\frac{2}{10}$ square inches. Then the

extreme pressure which the attached weights could produce upon the safety valve would be equivalent to 256 lbs. $\times$ 16.128 = $4128\frac{77}{100}$ lbs., or, per square inch of the valve = $20\frac{22}{100}$. This is exclusive of what is due to the weight of the valve, and its rod and lever, which may be estimated as follows: for the valve itself, without leverage, 100 lbs.; for the short, or primary, lever, 20 lbs. $\times \frac{17.5}{12.5}$ (the leverage of its centre of gravity) = 28 lbs.; for the connecting rod 10 lbs. $\times \frac{35}{12.5}$ = 28 lbs.; for the long, or secondary, lever, $56\frac{1}{2}$ lbs. $\times \frac{35}{12.5} \times \frac{33.5}{10}$ = 536 lbs, being in all 692 lbs. *at the seat of the valve:* and this will increase the whole pressure there to $4820\frac{77}{100}$ lbs., or to $23\frac{6}{10}$ lbs. per square inch of the valve and boiler.

This appears to be the highest pressure which could be brought upon the boiler by the system of weights and levers belonging properly to the valve.

The strength of the boiler, in its weakest places, being then estimated, as above, at $69\frac{44}{100}$ lbs. per square inch, amounted to just three times the extreme pressure which the engine builder appears to have intended it should be called on to bear, and in proportioning the strength of his work to the duty it was to perform, he would seem to have been sufficiently prudent. How, then, did the boiler explode, when guarded by a safety valve of such ample dimensions, designed to give way at one-third of the bursting strain?

That the free action of the valve must have been interfered with, would be a natural conclusion, and is corroborated by the testimony of one of the assistant enginemen, as will be presently mentioned. That the valve had been before loaded to produce a pressure greater than the limit prescribed by its own construction, may be inferred, indeed, from the statement of Mr. Watchman himself, who says, in his examination before the *Coroner's Inquest*, that the evening before the accident, the boiler was tried, and the valve raised with 27 inches of steam, or 27 lbs. per square inch, *as he had calculated*, and that on the previous Saturday, also, the boiler had been tried, and 31 lbs. per sq. inch put on. The lowest of these pressures being $3\frac{4}{10}$ lbs. per square inch beyond the above estimated extreme of $23\frac{6}{10}$ lbs., auxiliary means must have been employed to increase the steam pressure on the trials referred to, but as Mr. Watchman is silent on this point, and also as to the mode in which he arrived at the pressure, whether from an inspection of the mercurial gauge, or a calculation of the proportions, &c., of the valve, it cannot be known whether his calculation conflicts with the one I have offered. He says, furthermore, that about

half an hour before the explosion, he observed the gauge to show 10 inches of steam, and that he then tried to lift the safety valve, *but could not;* and after examining the rope attached to the valve lever, to see if it was on the pulley, he walked away. The result of this examination of the rope he does not state, but he seems to have had fears that some improper means of keeping down the safety valve had been used. That he should not have taken more pains to verify these fears, may well excite surprise. A very short time before the explosion, he says he was told by the acting engineman that the gauge showed 22 lbs. per inch of steam. Another witness says that when the weights were pushed out by him on the long lever, as far as they would go, the steam pressure was 22 inches by the gauge, having shewn 20 inches just before, and that by order of the acting engineman, he then put on *additional* weight, (how much he does not say,) and that two or three minutes afterwards, the boiler blew up. Another witness says that about the time the agent came on board, (some say 25 or 30 minutes before the explosion,) the gauge stood at nine inches.

This testimony agrees in showing that the pressure a half an hour before the accident, was 9 or 10 lbs. per inch, and that just before the boiler burst, it had risen to 22; higher than this it was not observed, except by a person who states that he saw the gauge-stick run up to the deck over it, immediately before the explosion. The evidence, also, of the witness "who put on the additional weight," that the pushing out of the weights *belonging to the valve*, as far as they would go, created a pressure of 22 lbs. per square inch, is confirmatory of the above estimate of the extreme pressure ($23\frac{5}{16}$ per square inch) which those weights were capable of producing, the difference of $1\frac{5}{16}$ lbs. being accounted for by the consideration that the elasticity of the steam would not instantly rise to an equilibrium with the increased pressure imposed by pushing out the weights, and that before the witness could observe whether the valve blew at $23\frac{5}{16}$ lbs. per inch, he had charged it still further with *extra weights.* That any extraneous means were employed to keep the valve down, has been denied by another witness, as I am informed, and have stated before; but the probabilities of the case are so much on the side of the positive declaration of the first witness, that an inquiry into the relative credibility of the two seems unnecessary. It being admitted, then, that new weights were added to those proper to the valve, the next question is, what must they have amounted to, in order to produce the explosion? The compound *leverage* of the valve is, as shown above, $\frac{1}{16.128}$ and its area, $204\frac{3}{16}$ square inches. The extreme pres-

sure it could bring upon the boiler, by its own weights, was $23\frac{6}{10}$ lbs. per square inch. The utmost pressure that the boiler could bear, is estimated at $69\frac{44}{100}$ lbs. per inch. Weight enough to raise an additional pressure of $45\frac{84}{100}$ lbs. per square inch, must then have been attached to the end of the valve lever, and, in order to effect this, the new load must have amounted to 580 lbs. Now it seems very unlikely that a weight, or weights, of such size or number, were in fact hung upon the valve lever, as that could scarcely have been done without detection, and it was manifestly intended to be a concealed act on the part of those engaged in it. The extra stress upon the valve, necessary to cause explosion, was then, most probably, produced by another mode than the suspension of weights from the lever —such as tying it down by its cord, or bracing it down by a strut between it and the upper deck—notwithstanding the averment of the witness, who may still have added new weights, but only to the extent of a part of the required surplus pressure, leaving the rest to be effected by other means applied by other hands. No matter however in what way the valve was kept down, so that it raised, as it did, the pressure to the explosive height, whatever that may have been.

But the boiler may have been in fact weaker than it has been estimated, from a deficiency of strength in the iron of which it was made, and which has been assumed at 55,000 lbs. per square inch. The numerous experiments that have been made upon the strength of this metal (of which those recorded in the Journal of the Franklin Institute, vols. xix and xx, 2nd series, are the most extensive and satisfactory that I have seen, and also the most applicable to the present case, as they were made upon boiler iron,) show that its cohesive power as often exceeds as it falls short of that measure, which may be taken as a fair average. If the iron of the Medora's boiler was, in fact, of bad quality, it may, however, have possessed a tenacity far within that just given; but it scarcely could have descended as low as the one-third of 55,000 lbs., or to 18,000 or 19,000 lbs. per square inch, which it must have done to have yielded to the steam pressure of $23\frac{6}{10}$ lbs. per square inch, supposing the preceding estimates of strength and pressure to be correct. My examination of the iron, as it appeared on the torn edges of the sheets, did not impress me with an unfavorable opinion of its quality, although it showed the distinctly laminous structure which most sheet iron exhibits. Its strength in the ruptured parts could not have been diminished by over heating, for those parts were far under the lowest level to which it is in the least degree probable that the water could have fallen, even had it declined below a safe and proper height. Moreover, the *strips*—the giving way of which caused the bursting of the boiler—were so situated that the fire

could not have been at all in contact with them had the boiler been *dry*, as they occupied the spaces over the legs, and, consequently, must have been always immersed either in water or steam. There is, however, no evidence that the water was deficient in quantity at the moment of explosion; on the contrary, many witnesses declared that the gauge cocks showed a full supply, and, considering the vast size of the boiler, the shortness of the time between the lighting of the fire and the occurrence of the explosion, it seems not likely that the evaporation could have sunk the water to a dangerously low level, if, as is to be supposed, it was properly filled at first. I could, indeed, discover no trace of injury to any part of the boiler by burning of the metal, and my examination of the uppermost tubes, and the top of the back smoke chamber, was very careful, and if these parts of the boiler *were* overheated, they, nevertheless, stood firm, and left the rupture to take place elsewhere. No incrustations likely to impede the transmission of the caloric to the water, and thus render the iron liable to burn, anywhere appeared, and were not to be expected in a perfectly new boiler. The degree of heat imparted to the parts of the boiler covered with water, would not, at all events, have exceeded the temperature due to the effective pressure of about $4\frac{2}{3}$ atmospheres, or $69\frac{44}{100}$ lbs. per square inch, which has been above estimated as sufficient to burst the vessel. This temperature (see Journal of the Franklin Institute, vol xvii, page 291, 2nd series,) is not more than 300 degrees of Fahrenheit, and the experiments recorded in the same Journal (vol. xx, pages 24 to 31, 2nd series, and curve-traced in plate X,) show that the tenacity of iron is *increased* by heat, until a temperature of at least 400 of Fahrenheit is surpassed, when it begins to diminish. The boiler, then, could not, in my opinion, have burst from overheating the metal *in the parts where the rupture actually took place*—to wit, in the strips over the legs, uniting the segments of the cylinder between them. In estimating the strength of these strips, I have supposed, from inspection and measurement of those that remain, that they contained one-half of the original quantity of metal in the sheets, which was further reduced to one-third of that quantity by the rivet holes. In this estimate there is room for mistake, and, possibly, I may have in this assigned more strength to the boiler than it in fact possessed. In both the quality of the iron and the amount of metal in the strips, then, there may be room for considerable reductions upon the preceding calculations of the ability of the boiler to withstand the pressure of the steam. Again, although the metal did not, on account of its greater strength than that of the strips, give way where, if at all, it must must have overheated—viz: in the top of the smoke box, or in the upper flues—there is a possibility that these parts

may have been laid dry by the falling of the water, and have become so hot as to generate suddenly a larger body of vapor (or, who knows, an explosive gas,) than the safety valve could vent with sufficient rapidity to save a rupture, even if that had been loaded to less than the strength of the boiler. This supposition is, however, in the face of the *evidence*, though, unfortunately, too little credit is due to such testimony in cases of this kind.

It is stated, by several witnesses, that the safety valve did not *blow* at all while the steam was getting up, and that from the time of making the fire, up to the moment of the explosion, not more than two or three short *puffs* proceeded from it. These would, indeed, suffice to show that it could not have stuck fast in its seat from the action of some adhesive force—an instance of which kind is on record. But it also proves that if, after all, the valve was not overloaded, at least the engineman and his assistants, &c., were strangely indifferent to the unusual absence of that audible evidence of its free action, which always attends the starting of a steamboat.

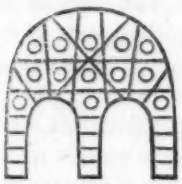
Although doubt must continue to rest upon the true and special cause of the explosion of the boiler of the Medora, and I am not prepared, in relation to that cause, to offer more than the preceding facts and inferences, for the judgment of others, yet some general conclusions may, I submit, be satisfactorily derived from the circumstances of this catastrophe. First—the boiler was too large in its diameter for the strength of metal employed, looking to the risk of bad materiai and workmanship. The thickness of the sheets was a quarter of an inch—a thickness, by the way, almost universally employed in the construction of steam boilers of all diameters, as if there were some magic in this particular dimension, which made it most pliantly applicable to all cases, however varying. Referring to the formula $x = \frac{2\,P\,t}{D}$ we find that iron one-quarter of an inch thick would require a pressure of 573 lbs. per square inch to rupture it in a cylinder of three feet diameter, (a diameter of usual occurrence in locomotive and other high pressure boilers,) if the modulus of its strength be 55,000 lbs. per square inch, and a deduction be made *for the seams*, of twenty-five per cent. While the Medora's boiler, of eleven feet diameter, and the same thickness and strength of sheet iron, would have borne but 156¼ lbs. per square inch, with a proportional reduction of one-quarter for the joints, (saying nothing of the still greater subtraction of strength due to the apertures over the legs,) can there be any propriety in using the same thickness of plate for each of these widely differing diameters? Yet it is done under the influence of the apparently *prescriptive right* of the quarter inch iron to be employed

in all cases whatever. It is true that the small diameter boilers are high pressure, and subjected to the greater strain, but their excess of strength is, at the same time, vastly greater than that of the large low pressure boilers. The usual high pressure strain is, perhaps, about 100 lbs., and the low pressure strain, 25 lbs. per square inch. The excess of strength in the three feet high pressure boiler is, then, 473 lbs. per square inch, and in the eleven feet low pressure boiler of the Medora, it would be but 126¼ lbs. per square inch. It may be said, indeed, that the ultimate strength of the former is but 5.73 times its usual strain, while that of the latter is 6.25 times its ordinary stress; also, that at the high temperatures accompanying high pressures, a given increase in the temperature causes a more rapid rise in the pressure than at the low temperatures of the lower pressures, so that there is occasion for more excess of strength in the former than in the latter cases, to guard against accidental augmentations of temperature. Also, that the consequences of explosion at high pressures are more disastrous than at those of a lower grade, and should, therefore, be more carefully guarded against. There may be some propriety in the two first of these suggestions, but not so much in the last, as some of the most fatal explosions have occurred in low pressure boilers; and still I think that low pressure boilers, whose diameters are generally from eight to nine feet, are usually too weak when made of quarter inch iron; and this opinion is held á fortiori in regard to the Medora, with her boiler of eleven feet across. Braces are indeed used in these large boilers, but with often only partial effect, and in the Medora, as has been already remarked, they could not be applied in the vertical, or radial, direction, in which they would have done most good, on account of the positions of the tubes.

Second—a boiler of the colossal size of that of the Medora, presents a bold and striking aspect, and seems fitted for the generation of a vast supply of steam; and so, doubtless, was the boiler in question, the fire surface and steam room of which was of unusually ample extent. But the same fire surface will be as effectual if distributed among two or three boilers, and with great increase of security against explosion. The one large boiler will, perhaps, cost less in the manufacture, and occupy less room in the boat, but it will be much more difficult to move, in placing and displacing it; and if accident happens to it, the supply of steam is wholly cut off; while with more than a single boiler, each of which can be insulated from the other, it may be kept up, and the engine worked at a lower speed, till the injured boiler is repaired.

Third—the design of a boiler resembling the Medora's, is deficient in strength at the junction of the belly with the legs which support it,

and form the sides of the fire-place. The perforations of the cylinder *must* be large enough to permit the water and steam bubbles to pass freely up and down, in the necessary circulation of them through the boiler. *Small* holes over the legs would not allow this; the circulation would be checked, less steam would be generated, and the legs of the boiler become unduly heated for want of the constantly required supply of cold water, which, in a boiler with no obstruction to circulation, is constantly descending towards the fire, from the upper and cooler parts of the vessel—towards which last, the steam bubbles are simultaneously rising to the steam chamber; the two currents thus running contrary to each, without mutual interference, as their very different specific gravities maintain an easy separation between them. Thus the *vertical* has an advantage, in regard to circulation, over the *horizontal* tubular boiler; the tubes of the former interfering much less with the passage of the two counter currents, and its fire-place being at the *bottom* of the boiler, instead of at one end of it, horizontally, gravitation gives more assistance to circulation. The maker of the Medora's boiler was right, therefore, in giving wide passages for water into the legs, but, as to do this necessarily weakened his boiler so much, it shows a faultiness in its plan. It is not, indeed, easy to see why he departed from the usual mode of building boilers of this character by arching the fire-places as in the accompanying drawing, and so arranging his flues as to permit numerous ties in a radial direction across the boiler, connecting the outer shell with the fire-arches, as well as the flues. Here no cutting of holes would have been required, and any degree of strength given without interference with circulation. The ties introduced into the Medora's boiler, are not in the most effective position. A tie, or brace, in a cylindrical boiler, should never, if possible, occupy any other position than that of a perpendicular to the surface, supported by the tie, or brace. Here they are *diagonal* to the ends and roof, and as chords, *less than diameters*, across the cylinder.



Some other obvious remarks suggest themselves, in conclusion, and are generally applicable to steamboats when under trial, on such occasions as this ill-fated vessel was about to begin.

Most of the persons on board the Medora, at the time of her explosion, were, as before stated, workmen who had been engaged in her construction. It was not safe to leave the boat as it *was* left, in the hands of these men, most of them, probably, reckless of danger, by character, and fired with the false ambition congenial to the occasion. The safety valve and mercurial gauge should have been constantly

under the eye of the engine builder, whose machine was being submitted to proof. The valve lever and its attached weights, and the means of moving them, should have been so constructed, and surrounded by guards, as to make it impossible that more than the extreme pressure designed to be put upon the valve, could be applied without doing violence to the defences of the apparatus. The boiler (as should all steamboat boilers,) should have been provided with a small pumping steam engine, to keep up the water, as at such times, especially, the boat has often to wait a good while before starting, the water gets low, and the engineman and his *assistants* (viz: the crowd around him,) are too excited, and anxious for a quick and favorable commencement of the trip, to go to work at the drudgery of pumping up by hand. Frequent trials of the state of the safety valve should be made, and it should not be left to *blow of its own accord*; at a safe pressure, but should be raised by force, and the surplus steam permitted to escape. This would prevent the valve from *adhering to the seat*, as it has been known to do, in consequence of the rusting of the iron, or the introduction of some glutinous, or cohesive, matter, thereto. The propriety of these and similar precautions, need not be enlarged upon. It is remarkable, and yet a clear consequence of the laws of mechanical *momentum*, that, in all these explosions, the rents made in the vessel should be so much greater than necessary to vent the steam and water with the rapidity that one would suppose far more than sufficient to relieve the pressure upon all other parts of the boiler than the part *first ruptured*, so much as to save them from injury. While the confined fluid is quiescent, however powerful its effort to escape, it does no harm, except in the preparation it is making to force an outlet, by gradually increasing its strain on the metal until an equilibrium is attained between the two forces of impact and resistance. But the instant that equilibrium is passed, upon a single square inch of the vessel, and the imprisoned fluid begins to put itself in motion, it breaks its way out, in a hundred directions instead of one, and we see parts of the vessel, of extremely unequal strength, giving way at the same moment. Thus in the Medora's boiler, the drawing shows several pieces blown out at the back, which were unquestionably far stronger than the strips of metal over the legs. The sudden escape of the steam and water, also, acting on the sides and bottom of the boat, give to the boiler that projectile force which throws it, en masse, into the air, and inflicts other great injuries in its fall. In all considerable explosions, indeed, the boiler has been more or less *displaced.*

Thus is demonstrated the unsoundness of the opinion that *simple pressure*, steadily increasing, within a steamboiler, ought to open the

seams, as being the weakest part of the vessel, and thus provide a safety valve, for the escape of the vapor. To account for the fact that boilers *never do give way in this manner*, the hypothesis of explosive gases has been paraded with, as I humbly conceive, very little foundation in fact, although rare instances of that description may have occurred, under particular circumstances.

Baltimore, August 2nd, 1842.

To the Committee on Publication:

Gentlemen—Having received the annexed *Official Report* from Major Baker, Commandant of the United States' Arsenal at Watervliet, New York, (where the preservative process has been several years in operation,) I hand it to you for publication, not doubting you will consider it as sufficiently a subject of general interest to entitle it to receive publicity through your Journal.

Respectfully, your ob't serv't,

Edward Earle.

Watervliet Arsenal, June 6th, 1842.

Report of the comparative Strength and Elasticity of Mineralized Timber and that in the Natural State.

To Major R. L. Baker.

Sir:—I have submitted to the proving machine twelve pieces of each kind, comprising oak, maple, birch, whitewood, or tulip tree, and pine.

The principal data recorded were—

1st.—Deflection with the constant weight of 383 lbs., (weight of apparatus.)

2nd.—Greatest deflection and weight while the elasticity was perfect.

3rd.—Ultimate deflection and *breaking weight.* The deflection was also generally taken for every additional weight.

Five minutes were allowed for a *set*, five minutes for *resilience*, and five minutes between each 20 lbs. added near the breaking point.

The proof pieces were 2 inches square, and 48 inches of effective length, prepared in November, 1840, by sawing blocks of large timber lengthwise, into battens, which were carefully finished by the plane to a square of 2 inches, and the weight of each taken to within 3 grains. One half of the battens from each prism of timber were selected for mineralizing, by taking, from a map of the end, every second piece over the whole area. They were mineralized in November, 1840, and since that date both kinds have been constantly in store,

and seem *absolutely dry*, many of them having lost from one-sixth of a pound to one-fifth of their original weight. It is somewhat remarkable that birch has lost less than other kinds, and some pieces have increased in weight from a few grains to more than a pound.

In the oak, pine, and whitewood, the average of the breaking weight was greatest in the mineralized pieces, equal in those of birch, and a little less in maple. Being called to other duty, the number of proofs in maple and birch were too few to be satisfactory; but thus far, the results lead to the decision that Dr. Earle's process *does not reduce the strength* of timber. The elasticity seems a little diminished in several, and perhaps further experiments may show some corresponding increase of strength.

Tabular Comparison.

	Mineralized.		Unprepared.	
	Greatest deflection.	Breaking wt.	Greatest deflection.	Breaking wt.
Oak . . .	2.37	1256	2.06	1226
Maple . .	1.50	1469	1.36	1617
Birch . . .	1.00	808	1.15	1014
Whitewood .	1.55	965	1.95	931
Pine . . .	1.25	729	0.82	589

Two contiguous battens on the map were selected—one cured, the other raw—and each reduced one-eighth of an inch on each face, to remove the part, if any, injured by the heat, and to render them of one size. The cured broke with 1022 lbs.; the other with 988 lbs.

A number of pieces of different kinds of timber were intentionally operated on *excessively*, by *repeated* and long boilings. In *all of these* which have been tried, the strength *appears diminished* in a slight degree.

All my observations, thus far, tend to corroborate the suggestion that *boiling heat is not necessary*, and that long digestion* is important; and, to prevent checking when taken out, that the timber ought to be *cooled in the tank.*

Respectfully submitted,

(Signed) R. M. Bouton.

* By "long digestion" is meant, a more protracted digestion than has been hitherto employed—that is, from one to two, three or more days, according to size, length, and kind of timber; and at a temperature short of the *boiling point*, or at 170° to 180° Fahr. A *short boiling*, of an hour or two, however, is recommended for timber of great size and length.

E. E.

To the above you will, I hope, permit me to add an extract which seems quite pertinent, from the last semi-annual Report of T. Tupper, Esq., President of the South Carolina Canal and Railroad Company, who has since last year been using this process on the railroad between Charleston and Hamburgh, South Carolina. Referring to a late advantageous purchase of timber for the road, (*at one-half the usual price*,) he says:

"This timber is obtained at a reduced price, as the sap is embraced in the square of the piece, and, consequently, taking a much less tree than when the heart only is retained.

"The advantage of this process will be felt at once in the lower price at which the timber is contracted for, and should it only last as long as ordinary timber, no expense will have been incurred, as the difference in the price of the timber will pay the expense of preparation.

"The timber prepared four years ago, with corrosive sublimate, is still sound, the sap of which has already shown a durability of double that of unprepared wood, and, from all appearance, will be sound when the unprepared is so rotten that it cannot be separated from the earth in which it is buried."

Here is a most important fact ascertained—the effect of corrosive sublimate on the sap-wood of timber—from which President Tupper derives the practical and useful inference that the sulphates of iron and copper—which have been fully ascertained to affect timber in the same manner as corrosive sublimate—must also render sap-wood, at least as durable as the heart is without them, and, by thus reducing the price of timber *one-half*, annihilate the cost of the process.

E. Earle.

Philadelphia, September, 1842.

Sketch of a Self-acting Flash-board, invented by Mr. John Chase, *and now in use upon a Mill-dam at Cabotsville, in the state of Massachusetts. Communicated by* E. P. Huntington.

The diagram below is an end view of a dam, with a self-acting flash-board, on a scale of one-twelfth the size. It was invented by Mr. John Chase, agent of the Springfield Canal Company, Cabotsville, Massachusetts, and is now in use there. Its design is to obtain a permanent additional supply of water in a mill-dam, equal to six inches head, and at the same time to avoid damage from back water, to those using it on the stream above, when it is high. Its cost is about three dollars per foot lineal.

Description of the Sketch.

A, pond.

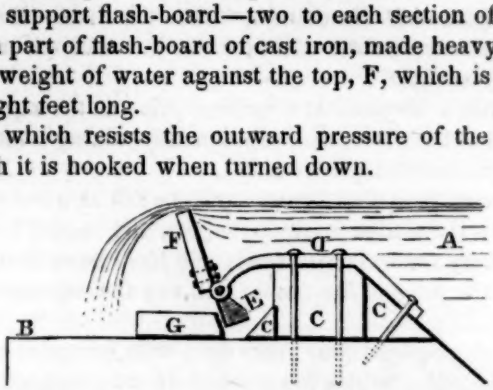
B, top of dam.

C, C, C, timbers spiked on the top of the dam.

D, iron to support flash-board—two to each section of eight feet.

E, bottom part of flash-board of cast iron, made heavy, to counterbalance the weight of water against the top, F, which is oak. Each section is eight feet long.

G, timber which resists the outward pressure of the flash-board, and to which it is hooked when turned down.



By this arrangement, when the water rises to about two inches above the top of the flash-board, the pressure is sufficient to carry the top, F, over to G, and as the water falls, the pressure is less, and it rises—*thus providing a due supply, but never an excess, when the water is abundant.*

Description of a new Self-acting Weir and Scouring Sluice, invented by Mr. Bateman, *an English Civil Engineer.*

We find in the London Civil Engineer and Architect's Journal, for August, 1842, the following account of a self-acting weir and sluice, brought before the British Association for the Advancement of Science, at their late meeting, held at Manchester.

This sluice is an ingenious application to a different use of the same principle of action that is brought into play by Mr. Chase, in the flash-board above described; and it seems to us that upon light streams, Mr. Bateman's invention might often be made a valuable auxiliary to the works necessary for a flash navigation.

Mr. Bateman observed that the great objections to fixed weirs and dams were, that by causing a partial stagnation in the water above them, they allowed the bed of the stream to be silted up by the deposition of mud, gravel, &c., whereas the proposed weir would adjust itself to the various changes in the condition of the stream, and prevent any filling up of the channel by making the stream clear itself.

Mr. Bateman's weir is composed of two leaves, turning horizontally on pivots, which are placed below the centres of the leaves, so that the upper portions of them shall be of much greater area than the lower. The upper leaf is also far larger than the lower, and turns in

the direction of the stream, while the lower leaf turns against the stream, and overlaps the bottom edge of the upper leaf, and is forced against it by the pressure of the water. The comparative area of the leaves and position of the pivots, is so arranged that in ordinary states of the stream, the tendency of the current to turn over the top leaf is counterbalanced by the pressure of the water against the overlap of the bottom one, the counteracting pressures keeping the weir vertical and the leaves closed, the water flowing as usual through a notch in the upper leaf. But when the water rises above the usual level, the pressure above, from greater surface and leverage, overcomes the resistance below, and the top leaf turns over, pushing back the lower leaf, and thereby offering the least possible obstruction to the water, and giving a passage at the very bottom of the stream to the gravel or mud.

The following diagrams will explain the construction of the weir:

In answer to questions and objections, Mr. Bateman explained how difficulties arising from trees floating down, the complete turning over of the leaves, &c., might be obviated by suitable stops, grating, &c. Sir J. Robison observed that the Rotterdam Canal had weirs on a similar principle, but Mr. Bateman explained that those weirs turned vertically on their axis. Mr. Vignoles stated that from the cheapness and apparent advantages of this weir, he hoped it would be brought under the consideration of the Commissioners of the Shannon navigation, and recommended for trial on that river, to which it appeared peculiarly applicable.

Mr. Bateman, in obviating some difficulties suggested, explained that in a weir 20 feet long and five feet deep, which his drawings and model might be supposed to represent, the sum of the closing pressures would be 7956 lbs., and the sum of the opening pressures would be 7669 lbs., the pivots being so placed as to give the areas of leaves, above and below the lines of their axes, the ratio of two to one. The leaves would consequently be kept close by a force equal to the difference between these pressures—that is, 287 lbs. As the water rises these conditions would, however, be changed. Supposing the water to rise one foot, the additional pressure would be 1200 lbs., of which 800 lbs. would be exerted in opening, and 400 lbs. in closing, the leaves; and the result would be, that the sum of the opening pressures would exceed that of the closing, by 100 lbs. The leaves would, consequently, be opened. He also explained that the sills against which the gates are made to close, might be so regulated as to discharge the greatest floods of water without allowing the leaves to open more than a moderate quantity; if thought necessary, however, the gates ought to be allowed to assume a position perfectly horizontal in cases

of high floods, and thereby oppose the least possible resistance to the passage of the water. The sluice might also be protected from being choked with trees and brushwood floating down the stream, by means of a grating.

Franklin Institute.

Address of S. V. Merrick, *Esq., President of the Franklin Institute, preceding the reading of the Report of the Committee on Premiums and Exhibitions.*

Ladies and Gentlemen:

We are again assembled to perform a grateful duty—to mete out the reward to superior skill and ingenuity. This is the twelfth occasion on which this Institute has drawn together the products of American industry; each time with the gratifying result of being able distinctly to mark the progressive improvement of our countrymen in all the arts necessary to the comforts of man.

Those among us familiar with the history and acts of this institution from its formation, and who can trace from step to step the development of the arts, as evinced by its exhibitions, compare with pride and pleasure the display which has now been made with those of former years, and especially that held in 1824, the first experiment of the kind in this country.

At that period, almost the existence of a national manufacture at all commensurate with the wants of the people, was doubted. So great was the prejudice against the American fabric, that the manufacturer who had made any progress towards perfection was, in many cases, obliged to dispose of his products as foreign. The astonishment of the public who were then for the first time made acquainted with the existence of many branches of art which the collection at the Institute opened to their view, and the patriotic feeling which manifested itself, gave a strong impulse to our infant manufactures, and determined the Institute to continue its course, and periodically to collect and display the specimens of art, for the purpose of showing at a single glance the progressive advancement made by the American manufacturer towards perfection.

In these efforts, the Institute has been amply sustained by the skill of the producer, the zeal and industry of its committees, and the liberality of the public.

All parties have appreciated the importance of these periodical exhibitions to our *common* country, and all in their respective spheres have lent efficient aid, and none more so than our fair friends, without whose countenance and support no such enterprize, however worthy, can hope to succeed.

The present exhibition, although not the most extensive which has ever been accumulated under the care of the Institute, is by far the most perfect in most branches of the arts, and evinces so decided an advance towards perfection, as to warrant the belief that the day is

not far distant when all the wants of the community may be supplied by domestic industry.

It is not in the coarser articles only that America is now independent of the foreigner. A glance over this hall will convince the most prejudiced that he need not blush to appear in an American coat. Nor is it any longer necessary to appeal to the patriotism of the ladies for the support of our manufactures. This room will furnish a female attire, from the bonnet to the shoe, which will bear a proud comparison with the products of any foreign country.

The manufactures of our country have taken deep root. The skill, industry, and ingenuity of our mechanics are unrivalled. Let the fostering hand of public opinion sustain them, and the whole community will reap the advantage. "United we stand—divided we fall."

The Report of the Committee on Premiums and Exhibitions, will now be read, with the award of premiums by the Managers. But, first, allow me to tender the sincere thanks of the Institute to the gentlemen of the Committee of Arrangement, who have devoted so much time to this collection and display—to the judges appointed on the various branches of manufacture, to whose prompt attention and impartiality we are indebted for this early award, and to the gentlemen of the public press, who, with untiring zeal worthy of the cause, have daily spread before the public full and judicious reports of all the articles in the saloon. To their liberality and public spirit, the Institute is especially indebted.

Report of the Committee on Premiums and Exhibitions of the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, on the Twelfth Exhibition of American Manufactures, held in Philadelphia from the 18*th to the* 31*st day of October,* 1842.

The *Committee on Premiums and Exhibitions* report that, having brought their labors in reference to the awards of medals and certificates to a close, they respectfully present them to the Managers for examination.

The usual arrangements for holding the Exhibition of Domestic Manufactures were made, and the day of opening fixed for Tuesday, the 18th of October. Every endeavor was used to give publicity to the fact that the exhibition was to be held, and that it would be opened on *that* day, in order to avoid the disappointment to depositors resulting from too late a presentation of their deposits, which so frequently excludes them from the examination of the judges and the award of premiums. In all these preparatory steps, a zeal and interest was manifested by the Committee of Arrangement, which was an earnest of the efficient services rendered by them since the opening of the exhibition. These services must, and doubtless will, receive the best thanks of the Managers of the Institute, and of the mechanics and manufacturers generally.

The place of holding the meeting was, after much discussion, fixed at the Museum building. The advantages and disadvantages of the

location—of the change from a suite of many rooms to a single large hall—and all other circumstances bearing upon the question, were fully considered. Notwithstanding that the prepossessions of the visiters must have been in favor of the former place of exhibition, the present locality appears to have given great satisfaction. By a division of the room by tables, for the display of articles, a sufficient length of show surface was obtained, and an extent of promenade afforded which satisfied even the most exacting. From certain points in the room, the general view was very pleasing, taking in at the same glance the numerous and varied objects of art and manufacture which filled the body of the room, and the moving groupes in the intervals engaged in their examination. The facilities afforded for putting the stoves and grates in action, have added much to the interest of one of the most useful branches of the exhibition; and the politeness of the occupants of the adjacent houses, and especially to Mr. Welsh, to whom the thanks of the Managers are justly due, enabled us to occupy a large area exterior to the exhibition hall and directly communicating with it.

There being but one chief hall of exhibition, has given rise to the impression that the number of articles exhibited is very considerably less than on former occasions. This, however, is by no means the case. It is true that the number and variety of the articles, in some particular departments, have not been quite so great as at the last exhibition, but this has been much more than counterbalanced by the choice nature of the specimens produced. In this respect, the present exhibition has surpassed all that preceded it. Notwithstanding the depression in all branches of industry, new fabrics and articles have appeared in many of the departments in useful lines of trade, and with a degree of perfection, and at prices which will secure a market for them.

Where so much merit appears, discrimination is invidious, and indiscriminate notice bears the aspect of fulsome praise. In illustration, however, of their position in reference to the excellence of the exhibition, the Committee would refer especially to the display of cotton, woollen, and silk goods; of stoves and grates, and of new and useful articles of hardware.

The judges have bestowed an amount of attention in the minute examination of the articles submitted to them, which merits the thanks of the Managers, and which should secure the approbation of the depositors. They have left but little more for the Committee to do than to make a compilation and very general revision of their labors. But two of the Committees of judges failed to present reports, most creditable to their authors. Each article, in turn, is commented upon, and the discriminating remarks show the unwearied patience with which these gentlemen have applied themselves to their work. It has been thought, by the Committee, that visitors should have an opportunity of examining the articles to which medals, or certificates of honorary mention, have been awarded. This new feature in the arrangements has required that the reports of the judges should be presented on or before the day when the awards are to be made. Some years

ago, this would have been deemed an *impracticable result* to attain; but the interest now excited by the biennial displays of American ingenuity and skill, has increased; those immediately engaged in their superintendence feel the stimulus, and require merely that this much should be pointed out, to be resolute for its execution. All the reports, with the exceptions before noted, have been received.

In recommending to the Managers the awards, the Committee have, of course, in general, followed principally the indications of the Committee of Judges, exercising only the power reserved to them, that chiefly to make awards in case of special merit to articles which do not come within the lists of the judges. The particulars of the action of the Committee, may be inferred from the introductory remarks to each of the separate heads, or departments, into which the specimens have been classed.

Public attention has been steadily turned towards the present exhibition, and on each day since the opening, with the exception of one, when the weather was unfavorable, the attendance of visitors has been most encouraging.

The loss met with in the robbery of one of the offices for the receipt of money, has rendered every offering acceptable, and the Committee hopes that the community may be induced to remember this as a motive to return frequently, in addition to those of curiosity or interest in the exhibition.

As many of the scholars from the Public Schools, and other institutions, as the convenience of our visitors would permit, were invited to the exhibition, in the hope thereby to encourage early a spirit of admiration of the resources of the great country of which they are one day to be citizens. It was not one of the least interesting parts of the exhibition to see these eager and attentive throngs, passing with regularity and order through the windings of the hall, forming at times a continuous line, nearly from the door of entrance to that of exit.

All the attendant circumstances of this exhibition, with the exception before noted, have been of the most satisfactory character, and show that the system once understood, is readily managed by the Committees, and acquiesced in cheerfully by the depositors and the public generally. The Committee feel gladdened by these results. However toilsome the effort to the members of the Institute, their reward is ample. However troublesome to the manufacturers or mechanics, or to the depositors, their return is certain. All must be gratified in being instruments of public good, and the manufacturer and mechanic, especially, must feel that he has a full recompense for exertion in the sympathy of the public, with the successful efforts of American industry.

The Committee proceeds to pass in review the several divisions of the exhibition, commenting upon them, and stating the awards, which they recommend for the approval of the Board of Managers.

I.—*Cotton Goods.*

This branch of domestic manufactures has steadily and rapidly im-

proved. The exhibition of this year was more remarkable for the excellence than for the extent or novelty of the fabrics. The improvement in printed goods was especially remarkable; a few years since foreign goods supplied our market in this branch almost entirely, now the domestic articles are so cheap, and of such good quality, as almost to exclude the foreign.

In accordance with the recommendation of the judges, the Committee makes the following awards:

To Perkins & Wendell, of La Grange, Philadelphia county, Pennsylvania, for No. 493, consisting of printed cottons, among which the judges specially designate a "light ground London style, and black ground Hibernia chintz," "three-colored stripes, and also rich green ground stripes." A Silver Medal.

To R. Garsed & Brothers, of Pennsgrove, Delaware county, Pennsylvania, for No. 263, deposited by them, cotton and worsted damask table covers, considered to merit a medal on account of novelty and excellence. A Silver Medal.

To James Wright, of Philadelphia, for No. 20, samples of Turkey red yarn, which possesses the qualities of eveness and strength, and has stood the action of chemical tests nearly as well as the imported yarn. A Certificate of Honorable Mention.

While in the opinion of the Committee this article is still inferior to the foreign, they desire to encourage the manufacturer to proceed in his efforts to bring it quite on an equality with the imported.

To Thomas Poole, of Philadelphia, for No. 21, cotton and worsted nett suspenders, remarkable for the smoothness and regularity of the web, and for strength and elasticity.

A Certificate of Honorable Mention.

To B. Starkey, of Philadelphia, for No. 92, quarter plaid ginghams, bearing a close resemblance to the Earlston gingham.

A Certificate of Honorable Mention.

The Committee of judges speak favourably of the work of other manufacturers. Their minute report, together with that of Dr. A. D. Chaloner, by whom the examination of the colors of the Turkey red yarn, No. 20, was made, will be published with the general report of the Committee. The importance of this branch of manufactures would induce the Franklin Institute to give every encouragement and all the publicity in their power, to the meritorious results of those engaged in it.

II.—*Woollen Goods.*

The display of woollen goods was varied, of superior quality, constituting one of the most prominent objects in the present exhibition. In accordance with report of the judges, the Committee has made the following awards:

To Edward Harris, Woonsocket, Rhode Island, for No. 468, deposited by him, merino cassimeres, "showing great skill, and a high degree of improvement in the manufacture." A Silver Medal.

To the Ballard Vale Co., Andover, Massachusetts, for No. 244, deposited by Paul Farnum & Co., consisting of white and scarlet flannels. A Silver Medal.

The judges remark of the specimens, that part of them possess the "unshrinking quality so highly prized in this article."

To the Rochester Mills, New Hampshire, for No. 475, very superior white Mackinac blankets, of remarkably pure and soft wool.

A Silver Medal,

To Duncan & Cunningham, of Belleville, New Jersey, for No. 471, deposited by them, seven embroidered woollen shawls.

A Certificate of Honorable Mention.

To the Middlesex Manufacturing Company, of Lowell, Massachusetts, for No. 488, deposited by Stone, Slade & Farnum, for four pieces of wool black cloth. A Certificate of Honorable Mention.

The judges considered these articles as remarkable for color, finish and quality.

To the Middlesex Company, Lowell, Massachusetts, for No. 488, deposited by Stone, Slade & Farnum, Belgic cord, a new article, in the manufacture of which, much skill and good taste are displayed.

A Certificate of Honorable Mention.

To the Middlesex Company, Lowell, Massachusetts, for No. 488, deposited by Stone, Slade & Farnum, double milled fancy cassimeres.

A Certificate of Honorable Mention.

To Wethered & Brother, Baltimore, for No. 469, double milled fancy cassimeres, to which the judges refer, especially to two pieces, as possessing the elastic property highly valued in French goods of this description. A Certificate of Honorable Mention.

To the Salisbury Company, Massachusetts, for No. 498, deposited by Waln & Leaming, scarlet and white flannels.

A Certificate of Honorable Mention.

The judges also speak favourably in their report of No. 576, four pieces of wool-dyed black cloth, manufactured by W. & D. Farnum, Waterford, Massachusetts, and deposited by them; of No. 470, white and scarlet blankets, made at the Rochester Mills, New Hampshire; of No. 520, wool-dyed black sattinetts, of fine material and strong fabric, manufactured by Wm. De Forrest & Co., Naugatuck, Connecticut, and deposited by Robert Grant.

Several very creditable articles in this department of the exhibition, were deposited too late to come under the notice of the judges.

III.—*Carpets and Oil Cloths.*

The Committee awards to the Thomsonville Manufacturing Company, Connecticut, for No. 419, deposited by Messrs. Hamilton & Daily, a two ply ingrain carpet, which, in the opinion of the judges, will compare advantageously with any article of the same kind now made. A Silver Medal.

To Andrew Johnson, of Cincinnati, Ohio, for No. 809, deposited by him, the best table oil cloth ever exhibited here. A Silver Medal.

To Andrew Alcorn, for an ingrain carpet, No. 139.

A Certificate of Honorable Mention.

To Hugh Smith, of Philadelphia, for No. 138, a list carpet, considered to be the best article of the kind exhibited.

A Certificate of Honorable Mention.

The oil cloths manufactured by Potter & Carmichael, and those by J. Macauley, Jr., are very excellent specimens, and will support the credit of the establishments where they were made.

To Wm. Silcox, of Philadelphia, for No. 518, manilla grass rugs, with woollen yarn borders. A Certificate of Honorable Mention.

IV.—*Silk and Manufactures of Silk.*

The specimens in this branch were very creditable to the manufacturers. The following awards are made:

To Mrs. H. McLanahan, of Philadelphia, for No. 351, three cases of reeled silk and sewing silk, for fringes, taken from an assortment kept for sale and not manufactured expressly for exhibition.

A Silver Medal.

To Samuel Ross, of Philadelphia, for No. 454, silk and hair damask seating, believed to be the first specimen of the kind yet exhibited.

A Certificate of Honorable Mention.

Beautiful specimens of the same kind of article, No. 717, manufactured by John George, of Philadelphia, richly entitled to a premium, were too late for competition.

To Wm. Morris Davis, Montgomery county, Pennsylvania, for No. 34, deposited by maker, two lots of raw silk, carried through the several processes from the worm to the hand, by the grower.

A Certificate of Honorable Mention.

To Miss A. E. Storer, of Philadelphia, for No. 351, one case of *reeled silk*, considered by the judges to be the best exhibited.

A Certificate of Honorable Mention.

To C. A. Walborn, of Philadelphia, for No. 24, stocks, part of which are made of American satin.

A Certificate of Honorable Mention.

To Geo. W. Ward, of Philadelphia, for No. 371, one case of stocks.

A Certificate of Honorable Mention.

To Ann Holt, of Philadelphia, for No. 207, six cards of silk covered buttons. A Certificate of Honorable Mention.

The judges also refer with approbation to a specimen of American satin, made at Economy, Pennsylvania.

As at former exhibitions, several deposites were made too late to be noticed, in accordance with the rules of the exhibition; the Committee regret to find on this list names which were excluded from the same cause from competition at the last exhibition.

An interesting letter from Mrs. McLanahan, giving particulars, which should form part of the documentary history of the silk manufacture in our country, is appended to the report of the judges. The Committee of Premiums has referred it to the Committee on Publications, to make such extracts from it as they may deem proper for publication in the Journal of the Franklin Institute.

V.—*Iron and Steel.*

The importance of this manufacture is felt by every intelligent member of the community, and its progress must be a source of legitimate congratulation. The depressed condition of the industry of

our country has in no branch been more deeply felt than in this, and it cannot be a matter of surprise, though it is of regret, that the promise held out at the last exhibition of so decided advance, especially in the manufacture of iron with anthracite as a fuel, has not been realized. The report of the judges upon the specimens submitted, is referred for publication to the appropriate committee. The following awards are made:

To James Wood & Sons, of Philadelphia, for No. 492, two bundles of imitation Russia sheet iron, of surface equally smooth with the imported article and of uniform color, a new manufacture.

A Silver Medal.

Messrs. Yeardsley & Forsyth, of Chester county, Pennsylvania, for part of No. 143, deposited by Morris & Jones, viz: a boiler head of rolled iron, 48 inches in diameter and half an inch thick.

A Certificate of Honorable Mention.

The judges also refer with commendation to a bar of rolled iron from the Colemanville works, and to a round bar of axle iron by Valentine & Thomas, of the Bellefonte and Juniata Iron Works; also to No. 118, a bundle of nail rods, deposited by E. J. Etting & Brother.

VI.—*Umbrellas.*

This is a department of manufacture which is attracting increased attention, and the specimens in which have been very creditable to the depositors. The judges recommend, and the Committee makes the following awards:

To Wright & Brothers, of Philadelphia, for No. 453, consisting of hollow ribbed steel frame silk umbrellas, with patent springs; of silk umbrellas with whalebone frames, and of gingham umbrellas of American gingham, rendered water proof by a cheap composition.

A Silver Medal.

To J. Morris, Heston & Co., of Philadelphia, for No. 189, a light colored parasol with the handle inlaid with mother of pearl.

A Certificate of Honorable Mention.

To McGowen & Brothers, of Philadelphia, for No. 202, a light colored sun shade. A Certificate of Honorable Mention.

VII.—*Lamps and Gas Fixtures.*

These were few in number, and the judges recommend no special awards. The lamps for burning camphine and lard, were good specimens of the modes of applying these materials to the purpose of illumination, and the display of lamps and gas fixtures by Cornelius & Co., sustained the character of these gentlemen for taste and skill.

VIII.—*Hardware and Cutlery.*

This branch of domestic industry present considerable novelty from year to year, owing to its rapid progress. The specimens exhibited this year, though not so numerous as at the last exhibition, were of remarkable excellence. The display of guns and rifles is especially praised by the judges, to whose report the Committee refers for the particulars of the exhibition of hardware and cutlery. Great pains

have been taken in examining the various articles, and the report upon them by the judges is so full that the Committee has merely to follow it in making the awards. The following are accordingly made.

To George Machin, of Philadelphia, for No. 124, a card of files and rasps, comparing favorably with the best imported articles of the same kind. A Silver Medal.

A question having been raised in reference to the manufacture of these articles, the judges obtained evidence entirely satisfactory to them, that they are of domestic workmanship.

To Bradley & Beecher, of Naugatuck, Connecticut, for No. 295, two cases of pen and pocket knives, of excellent quality and various patterns. A Silver Medal.

To the New England Screw Co., Providence, Rhode Island, for No. 345, deposited by Curtis & Hand, for samples of screws of most admirable workmanship. A Silver Medal.

To R. Heinisch, for No. 243, a case of tailors' and bankers' sheers. A Silver Medal.

The judges recommended an award for No. 510, specimens of iron butt hinges, made by W. Hart Carr, combining strength and durability with cheapness, but as Mr. Carr is a member of the Board of Managers, the regulations of the Institute forbid the award.

To L. Goujon & Sons, of Philadelphia, for No. 51, wood screws and rivets. A Certificate of Honorable Mention.

To E. Hunt & Brothers, of East Douglass, Massachusetts, for No. 109, six scythes, "well made, and worthy the attention of the trade." A Certificate of Honorable Mention.

To William Robinson, of Philadelphia, for Nos. 135 and 563, two rifles, considered by the judges beautiful specimens of American work, and a beautifully finished double barrelled gun. A Certificate of Honorable Mention.

To John Krider, of Philadelphia, for No. 283, a case of admirably made guns. A Certificate of Honorable Mention.

To the Home Manufacturing Company, of Birmingham, Connecticut, for No. 414, deposited by Wightman & Wilcox, sample of machine made pins. A Certificate of Honorable Mention.

To Homer, Foote & Co., of Springfield, Massachusetts, for No. 345, deposited by Curtis & Hand, a case of Screw wrenches. A Certificate of Honorable Mention.

To T. Rowland & Brothers, of Philadelphia, for No. 538, an elliptic spring, superior to any thing of the kind before exhibited here. A Certificate of Honorable Mention.

To G. & W. N. Ropes, Maine, for No. 702, deposited by Thomas Zell & Co., a card of well made knives and forks. A Certificate of Honorable Mention.

To Samuel Jackson, of Baltimore, for No. 447, deposited by George P. Schively, three pocket knives and one case of razors, skilfully and tastefully made. A Certificate of Honorable Mention.

To Tryon & Sons, of Philadelphia, for No. 848, a rifle and pistols, remarkably well made in every respect. A Certificate of Honorable Mention.

To Haywood & Sturdevan, for No. ——, deposited by W. P. Cresson & Brothers, a box of machine-made horse nails.

A Certificate of Honorable Mention.

To James Barton, of Philadelphia, for No. 457, a lock for fire proofs.

A Certificate of Honorable Mention.

To Pierpont & Hotchkiss, New Haven, Connecticut, for No. ——, deposited by W. P. Cresson & Co., two stands of door locks and knobs of excellent workmanship.

A Certificate of Honorable Mention.

To Rodenbough, Stewart & Co., of South Easton, Pennsylvania, for No. 345, deposited by Curtis & Hand, and by Livingston & Lyman, two bundles of fine iron wire, well polished and of uniform thickness. A Certificate of Honorable Mention.

To Spang & Wallace, for No. 80, an elegantly finished rifle.

A Certificate of Honorable Mention.

To Joseph McCredy, of Philadelphia, for No. 43, a case of woven wire for paper makers, one piece of which is of extraordinary width of excellent manufacture. A Silver Medal.

IX.—*Saddlery, Harness and Trunks.*

The specimens of these articles were by no means so numerous as at former exhibitions, nor so well calculated to attract attention. The judges speak well of them generally, and in accordance with their remarks, the Committee makes the following awards:

To Thomas Moyer, of Philadelphia, for part of No. 158, the trunk and saddle without a pad, which are severally considered to be the best exhibited. A Certificate of Honorable Mention.

To W. N. Lacey, of Philadelphia, for No. 107, a set of single and of double harness, calculated to add to the credit of American workmanship in this department. A Certificate of Honorable Mention.

To R. Carey, of Philadelphia, for part of No. 326, a shaftoe saddle, with a spring bar, and without a pad.

A Certificate of Honorable Mention.

To Francis, Field & Francis, of Philadelphia, for No. 205, consisting of saddlery ware, the japanned work of which is especially referred to by the judges. A Certificate of Honorable Mention.

To Mahlon Warne, of Philadelphia, for No. 505, a sulkey bridle without winkers, which vies with the same part of the "Ashburton harness." A Certificate of Honorable Mention.

To William P. Taylor, of Philadelphia, for No. 180, deposited by B. F. Taylor, a valise trunk. A Certificate of Honorable Mention.

X.—*Models and Machinery.*

The specimens of this important department were by no means as interesting as those presented at previous exhibitions. The judges reflect with considerable severity upon the character of some of the workmanship. Nevertheless certain of the articles were of great value in reference to the ingenuity of invention, and many were also very creditable specimens of work. The Committee makes the following awards, founded upon the detailed report of the judges:

To Alexander Calderhead, of Philadelphia, for No. 516½, a carpet loom, remarkable for its simplicity and efficiency.

A Silver Medal.

To John O. Bradford & Co., for No. 660, a knitting machine deposited by them, and made by Eastwick & Harrison, of Philadelphia, of the ingenuity and usefulness of which the judges speak very highly.

A Silver Medal.

To Parson & Wilder, Hoosick Falls, New York, for No. 99, deposited by J. B. Hughes, an improved cloth shearing machine.

A Certificate of Honorable Mention.

To Oare & Pittman, Lowell, Massachusetts, for No. 175, an improved machine for carding wool.

A Certificate of Honorable Mention.

To C. H. Eisenbrandt, Baltimore, Maryland, for No. 822, deposited by maker, a writing machine for the use of the blind.

A Certificate of Honorable Mention.

To T. Mason, of Philadelphia, (a youth,) for No. 315, a complete working model of a fire engine, very beautifully executed.

A Certificate of Honorable Mention.

The Committee further awards to W. A. Armstrong, of New York, for No. 751, a knife cleaner, well adapted to use in large families.

A Certificate of Honorable Mention.

Also to Samuel Pennock, of Kennett Square, Pennsylvania, for No. 871, an ingenious drilling machine, for planting corn, wheat, &c.

A Certificate of Honorable Mention.

The judges recommend for examination by the committee on Science and the Arts, No. 338, a model of a three-ply carpet loom, by J. A. Scott, No. 352, a model of a compound capstan, by R. C. Taylor, and No. 278, a stone cutting machine, by Hines & Houpt.

The beautiful self-acting medal ruling machine, by Joseph Saxton, of the U. S. Mint, excited general admiration. As Mr. Saxton is a member of the Board of Managers, no further notice can be taken of it here.

To J. M. Clintock, of Philadelphia, for No. 380, a mortising machine.

A Certificate of Honorable Mention.

The Committee would have made an award to Wm. Smith, of Philadelphia, for No. 813, a bank note transferring press, had it been brought to the exhibition in time.

A lathe by Charles L. Oram, is worthy of notice.

A fire engine, deposited by John Agnew, is very creditable to him as a manufacturer of this article. Mr. Agnew being a member of the Board of Managers, no award can be given to it.

XI.—*Stoves and Grates.*

In no branch of the exhibition has there been a greater amount of competition than in this. The specimens of stoves for parlors and kitchen use, and the cooking ranges were numerous, and the locality of the exhibition afforded an excellent opportunity for showing practically the various merits of the different forms. In all of those made

of cast iron, the improvements in the art of iron founding were distinctly to be marked.

The judges were of opinion that no one of the cooking stoves was superior in usefulness and durability to some which have received the premiums on former occasions. The cooking ranges were in general those which have already met with commendation, one of them, however, presenting novel features, is recommended for the award of a medal.

As the opinion of the Committee of judges is fully given in their report, it has been referred for publication in the Journal of the Institute.

The Committee awards to Julius Fink, of Philadelphia, for the cooking range, No. 42, deposited by him. A Silver Medal.

To John Estlin, of Philadelphia, for No. 261, a cooking stove.
A Certificate of Honorable Mention.

To Pleis, Foering & Co., of Philadelphia, for No. 438, "a salamander stove with a very convenient appendage for heating sad irons."
A Certificate of Honorable Mention.

This stove is understood to be the invention of Mr. Frederick Foering.

To J. L. Mott, of New York, for No. 487, deposited by Dewitt C. Mott, consisting of several stoves, with new and ingenious contrivances. A Certificate of Honorable Mention.

To J. L. Mott, of New York, for No. 487, deposited by Dewitt C. Mott, a portable open boiler, or cauldron, and furnace.
A Certificate of Honorable Mention.

To Harned & Elliot, for No. 865, a parlor self-regulating stove, of remarkably neat form, for burning coal, combining great economy of fuel, with cleanliness.
A Certificate of Honorable Mention.

To Samuel R. Andrews, of Philadelphia, for No. 495, a cooking range. A Certificate of Honorable Mention.

To Samuel Lloyd, Philadelphia, for No. 667, a cooking range.
A Certificate of Honorable Mention.

XII.—*Cabinet Ware.*

No department of the decorative arts has shown more improvement than this, in the quality of the articles exhibited. The report of the judges is full and explicit, and containing hints which may be of service to this branch of art, is referred for publication.

To C. H. & J. F. White, for a sofa and chairs, "very superior specimens of design and workmanship." A Silver Medal.

To J. & A. Crout, of Philadelphia, for No. 121, a centre table of Lombardy Poplar, remarkable for "boldness and beauty of design, and elegance of workmanship." A Silver Medal.

To J. P. Sherborne, of Philadelphia, for No. 79, two dressing bureaus, "beautiful specimens of furniture, in the Tudor Gothic style."
A Certificate of Honorable Mention.

XIII.—*Musical Instruments.*

The judges have, as usual, given much attention to the examination of the instruments produced for exhibition. They speak highly of the pianos as presenting, on the average, an improvement upon those exhibited in former years, but do not consider the excellence of any one or more as sufficiently marked to require the award of the highest honors of the exhibition. Their report has been referred to the Committee on Publications. They notice especially No. 276, from the manufactory of Messrs. Reichenbach & Co., of Philadelphia; No. 521, from A. H. Gale, of New York, deposited by J. C. Smith; Nos. 282 and 246, from C. Meyer, of Philadelphia; and No. 123, from the Manufacturing Company of Philadelphia.

In accordance with their recommendation, awards were made,

To T. J. Weygandt, of Philadelphia, for No. 227, an eight keyed flute, remarkable for its strength of tone and fullness, and richness in the lower parts of the scale. A Certificate of Honorable Mention.

To J. Pfaff, of Philadelphia, for No. 396, an eight keyed flute, admired for the "sweetness and richness of its upper notes."

A Certificate of Honorable Mention.

XIV.—*Glass, China and Earthenware.*

One of the most interesting and generally noticed portions of the display at this exhibition consisted of the articles of earthenware.

The articles, No. 106, made by Abraham Miller, consisting of the finer kinds of earthenware, as plates, vases, and ornamental flower pots, were recommended for a premium, but in consequence of Mr. Miller being a member of the Board of Managers of the Institute, this cannot be awarded.

The Committee awards to the American Pottery Company, of Jersey city, for No. 31, deposited by Peter Wright & Sons, and consisting of embossed-ware jugs, tea ware, spittoons, &c., of spittoons with white raised figures, of druggists' jars, &c. A Silver Medal.

To the Boston and Sandwich Glass Company, for the best display of cut glass in the exhibition, deposited by W. M. Muzzey, S. Tyndale and James Kerr. A Silver Medal.

To the Union Glass Works of Philadelphia, for No. 147, deposited by Charles B. Austin, the best specimen of colored glass exhibited. A Silver Medal.

To Coffin, Hay & Bowdle, of the Jersey Glass Works, for No. 159, deposited by them, window glass, showing improvements in this useful branch of manufacture. A Certificate of Honorable Mention.

To C. M. Greiner, of Philadelphia, for No. 9, specimens of painting upon porcelain. A Certificate of Honorable Mention.

It is to be regretted that the artist has expended so much labor and time in decorating an inferior porcelain article of foreign manufacture.

XV.—*Paper Hangings.*

Although the excellence of the specimens of paper hangings was as

great as at the last exhibition, the number and variety was very much reduced. The Committee, nevertheless, agrees with the judges in the opinion that the intrinsic excellence of the articles presented by Howell & Brothers, entitles them to high commendation. The Committee awards to Howell & Brothers, Philadelphia, for No. 36, deposited by them, specimens of paper hangings in various styles.

A Certificate of Honorable Mention.

XVI.—*Books and Stationary.*

The judges speak in terms of high commendation of the improvement manifested in all the parts of what may be called the manufacture of books, including the paper, the typography, and binding, beautiful specimens of which have this year been exhibited. There was no novelty in the exhibition of paper; the same varieties, and from nearly the same makers, having been presented as at the last exhibition. Many articles of stationary were for the first time produced, with a perfection which must establish their use in the stead of the corresponding imported ones.

The printing papers of Tileston & Hollingsworth, of Milton, Massachusetts, and of H. V. Butler, of Paterson, New Jersey, are favorably noticed by the Committee of judges. The copper plate printing paper of Tileston & Hollingsworth, received special notice at the last exhibition, as was also the case with the colored papers for lining books, make by R. & A. H. Hubbard, of Norwich, Connecticut.

In book-binding, the Committee awards to Benjamin Gaskill, of Philadelphia, for No. 381, excellent specimens of book-binding.

A Certificate of Honorable Mention.

To Lippincott & Co., of Philadelphia, for No. 435, containing beautiful specimens of binding. A Certificate of Honorable Mention.

The judges particularly refer to the execution of the edition of Byron, which is one of the books exhibited in No. 435, highly commending every part of it, and especially noticing the stereotyping by Mr. Fagan.

To C. Carle, of Philadelphia, for No. 157, specimens of book binding, designed with taste and executed with skill.

A Certificate of Honorable Mention.

To Johnson & Smith, Philadelphia, for No. 1, containing specimens of types made by them.

A Certificate of Honorable Mention.

To Carey & Hart, of Philadelphia, for No. 385, the Gift for 1843, entirely of American materials.

A Certificate of Honorable Mention.

In the articles of stationary, the judges refer with the highest praise to the superior work of the Blank Books, manufactured by Hogan & Thompson, of Philadelphia; also to the steel pens, the wafers, sealing wax and ink, exhibited by them, for which, however, no award can be made on account of Mr. Thompson's position as a manager of the Institute. The blank books bound by Thomas Leitch, and by Messrs. Lippincott & Co., are also noticed.

The writing papers of Jessup & Brothers, of Westfield, Massachu-

setts, and of R. & A. H. Hubbard, of Norwich, Connecticut, were noticed at the last exhibition.

The Committee now awards—

To Joseph C. Robinson, for No. 391, deposited by Mr. Conrad, a beautiful specimen of large writing paper.

A Certificate of Honorable Mention.

To the Wading River Co., of McCartyville, New Jersey, for a specimen of cloth paper, contained in No. 455, deposited by Wm. McCarty. A Certificate of Honorable Mention.

The different black inks exhibited were found to be of good quality.

The admirable wall paper of C. &. W. H. Magarge was noticed at the last exhibition.

The articles deposited by R. Lindsey & Co., fully sustained the reputation of that house, but were too late for competition.

XVII.—*Fine Arts.*

The following awards are made, with reference to the opinions expressed by the Committee of judges:

To A. Cornu, of Philadelphia, for No. 233; drawings of machinery, &c., executed with the pen, and remarkable for exactness and beauty.

A Certificate of Honorable Mention.

To J. Gibson, of Philadelphia, for No. 497; painted imitations of various woods. A Certificate of Honorable Mention.

To John T. Bowen, of Philadelphia, for No. 361½, specimens of colored lithographic prints, from drawings by Audubon.

A Certificate of Honorable Mention.

The judges also speak with commendation of No. 96, paintings of fruit, &c., by G. B. Ord; of No. 82, drawing of the excavator, for railroads, by S. R. Mason; of No. 462, imitation of crayon drawings, by Victor Ernette; of No. 850, machine drawings, by H. R. Campbell, and of No. 772, two views of the volcano of Katuca, in the island of Hawaii.

The Committee awards:

To C. K. Frost, of Philadelphia, for No. 70, beautiful specimens of engraving on wood, in different departments of the art.

A Certificate of Honorable Mention.

To T. Mumford, of Philadelphia, for No. 102, fine engravings on wood. A Certificate of Honorable Mention.

XVIII.—*Silver and Plated Goods.*

The report of the Committee of judges who examined the articles of this class, is clear and explicit; following its indications, the Committee of Premiums awards:

To Bailey & Kitchen, of Philadelphia, for No. 321, a silver tea service, with spoons, forks, &c., of beautiful design and workmanship.

A Certificate of Honorable Mention.

To Bard & Lamont, of Philadelphia, for No. 376, a fireman's horn, of silver, of fine proportions and finish.

A Certificate of Honorable Mention.

To Samuel Bland, of Philadelphia, for No. 209, a patent lever watch. A Certificate of Honorable Mention.

XIX.—*Book Binders' Tools.*

There can hardly be said to have been competition in this department of the exhibition, the specimens being in different branches of the art.

The following awards are made as most justly due by the intrinsic excellence of the work:

To Gaskill & Copper, of Philadelphia, for No. 23, containing various specimens of book binder's stamps, of beautiful workmanship, presenting improvement upon those heretofore exhibited by them. A Certificate of Honorable Mention.

To Allen Leonard, of Philadelphia, for No. 166, a brass die for embossing, exhibiting, according to the report of the judges, skill, taste, and judgment. A Certificate of Honorable Mention.

The steel dies for embossing, No. 398, by A. C. Morin, fully sustain the character of the work of that artisan.

XX.—*Marble and Statuary.*

The committee makes the following awards:

To Joseph Maples, of Philadelphia, for No. 254, a small sarcophagus, of Italian marble, of creditable design and workmanship, and a slab, with a shield encircled by a laurel wreath beautifully wrought. A Certificate of Honorable Mention.

To John McFadden, of Philadelphia, for No. 88, an Italian marble bath with figures inlaid, in imitation of Mosaic. A Certificate of Honorable Mention.

XXI.—*Hats and Caps.*

Few of these articles were exhibited. The judges mention the hats deposited by Charles Oakford, as remarkable for the fineness of the materials of which they are made, and speak favorably of the hats and caps deposited by Charles F. Raymond, of the hats and military caps deposited by John Simpson, and of the beaver bonnet deposited by Emmor Kimber, Jr.

An award is made to H. S. Miller, Philadelphia, for No. 355, deposited by maker, six hat bodies, which are in the opinion of the judges the best exhibited. A Certificate of Honorable Mention.

XXII.—*Combs and Brushes.*

The following awards are made to the makers of these articles:

To S. Winner, of Philadelphia, deposited by maker, for No. 226, a case of combs, good in style and workmanship. A Certificate of Honorable Mention.

To Meyers Busch, of Philadelphia, for No. 604, a case of fancy brushes. A Certificate of Honorable Mention.

The brushes made by the pupils of the Pennsylvania Institution for

the instruction of the blind, No. 313, are considered decidedly better aticles than those submitted at the last exhibition.

XXIII.—*Coach Work.*

Some of the specimens under this head, were much admired.—Awards were made:

To Ogle & Watson, Philadelphia, for No. 504, deposited by maker, the Ashburton carriage, pronounced by the committee of judges to be of superior workmanship. A Silver Medal.

To A. Knowles & Co., Philadelphia, for No. 73, deposited by maker, two neat and well finished sleighs.

A Certificate of Honorable Mention.

XXIV.—*Leather and Morocco.*

This branch of the exhibition was meagre indeed, in the number of specimens presented. Without entering into the reasons which might be assigned for this, the committee would observe that the manufacturers of our city alone, have not been fully represented in this article, and would recommend to the enterprising members of this trade to let the public have a fairer sample as to the extent of their work at the next exhibition.

The articles deposited by Scattergood & Boustead, by Lippincott, and by A. & J. Peterson, fully sustained their high reputation for skill in their art.

The Bag Hide, by Scattergood & Boustead, is a fine article, and would do credit to any shop or market.

A Certificate of Honorable Mention.

XXV.—*Boots and Shoes.*

In accordance with the spirit of the report of the Committee of judges, the following awards are made:

To J. A. Sengenberger, of Philadelphia, for No. 177, the best specimens of boots and shoes exhibited.

A Certificate of Honorable Mention.

To J. Thornley, of Philadelphia, for No. 363, India rubber shoes, which show considerable improvement in these articles.

A Certificate of Honorable Mention.

The judges speak favorably also of the India rubber boots and shoes exhibited by John L. Ripley, and express a regret that some of the best specimens of boots and shoes were brought to the exhibition too late to come under their notice.

XXVI.—*Chemicals.*

The specimens of chemical preparations were very beautiful.—Those of Wetherill & Brothers, Harrison & Brothers, Carter & Scattergood, and Farr, Powers & Weightman, are all spoken of in high terms by the judges. The glass, for chemical purposes, manufactured by the New England Glass Co., and deposited by W. M. Muzzey, is strongly recommended to chemists.

The judges recommend the following awards which are hereby made.

To Carter & Scattergood, of Philadelphia, for No. 297, a very beautiful specimen of Prussian blue

A Certificate of Honorable Mention.

To Farr, Powers & Weightman, of Philadelphia, for the general excellence of the preparations exhibited by them, Nos. 406 and 407.

A Certificate of Honorable Mention.

The Committee awards:

To Eugene Roussel, of Philadelphia, for No. 224, the best display of soaps, perfumery, &c., yet exhibited. A Silver Medal.

XXVII.—*Philosophical Apparatus.*

This is a growing and useful branch of the mechanic arts. The Committee regards the execution of the meridian circle, by William J. Young, as marking a new era in the application of the arts. The report of the judges, which is very full upon all the articles, is referred for publication. The Committee in accordance with the recommendations of the judges, awards:

To William J. Young, of Philadelphia, for No. 872, a five feet meridian circle, or transit instrument, copied from the High School Transit of Ertel & Sons, of Munich. A Silver Medal.

To A. D. Crane, for No. 356, deposited by Smith & Brothers, of Philadelphia, a clock with a torsion pendulum, a curious and compact form of mantle clock. A Silver Medal.

To James F. Duffey, of Philadelphia, for No. 256, various electro-magnetic instruments of neat execution.

A Certificate of Honorable Mention.

To Thomas Hill, of Cambridge, Massachusetts, for No. 517, a machine for assisting in determining the occurrence of time of occultations and called an "occultator." A Certificate of Honorable Mention.

To James Bingham, for No. 519, various articles of electro-magnetic apparatus, neatly executed.

A Certificate of Honorable Mention.

To H. M. Paine & Co., of Liecester, Massachusetts, for No. 857, periscopic and cylindrical spectacles.

A Certificate of Honorable Mention.

The judges also speak in terms of warm commendation of a gold lever watch, No. 209, the movement of which, except the chain and main spring, was executed by Samuel Bland; of a case of watch dials, No. 210, by Wm. J. Mullen; and of an admirably finished theodolite, No. 244, by Edmund Draper.

In the spirit of encouragement to youthful efforts, which the Franklin Institute has always manifested, the following award is made:

To James Duffey, Jr., of Philadelphia, for No. 275, containing, among other articles of philosophical apparatus, a model of a combination of machinery. A Certificate of Honorable Mention.

XXVIII.—*Straw Goods.*

In accordance with the recommendations of the judges, the award is made:

To Miss Blake, of Wrentham, Massachusetts, part of a case, No. 443, deposited by Thomas White, a straw bonnet, the beautiful plaiting of the material of which was executed by her.

A Silver Medal.

XXIX.—*Surgical Instruments, &c.*

There was not much variety in these articles. In accordance with the report of the acting judges, the Committee awards:

To E. Flohr, of Philadelphia, for No. 430, a mounted cranium.

A Certificate of Honorable Mention.

To B. C. Everett, of Philadelphia, for No. 334, a case of surgical bandages. A Certificate of Honorable Mention.

The abdominal supporter by Dr. Banning, although coming too late to enter into the competition, is thought so highly of by the judges on surgical instruments, that the Committee awards it,

A Certificate of Honorable Mention.

XXX.—*Copper, Brass, and Plumbers' Work.*

There was very little variety in the articles classed under this head. The judges speak favourably of the copper tubes for locomotive boilers, No. 49, by Wayne & Roberts, of Philadelphia; of the large bell, No. 357, by L. Debozear, of Philadelphia; and of brass castings, by Isaac Babbit, of Boston.

XXXI.—*Tin Ware.*

The display of tin ware was not more various than on former occasions, the judges recommend, and the Committee awards:

To Harned & Elliott, of Philadelphia, for No. 274, a tin ball, or sphere, twenty-eight inches in diameter, for a steeple ball.

A Certificate of Honorable Mention.

XXXII.—*Paints and Colors.*

The specimens of paints and colors exhibited were highly creditable to the manufacturers. The judges recommend the following award which is hereby made.

To R. A. Tilghman, of Philadelphia, for No. 548, specimens of superior chromate of lead. A Certificate of Honorable Mention.

The judgment of the Committee on chemicals, in reference to the excellence of the Prussian blue, No. 297, of Carter & Scattergood, is confirmed by the judges on paints and colors, who also recommend it to Honorable Mention.

XXXIII.—*Fancy Articles.*

It is believed that the quality of the specimens of fancy articles was better than at preceding exhibitions. The following awards are made in compliance with the recommendations of the Committee of judges.

To Thomas Bogue, of Philadelphia, for No. 309, "a case of gentlemen's wigs and scalps." A Certificate of Honorable Mention.

To F. J. Dressler, of Philadelphia, for No. 422, a case of fancy hair work—the best exhibited. A Certificate of Honorable Mention.

To T. B. Smith, of Philadelphia, for No. 516, an assortment of pickles of excellent flavor. A Certificate of Honorable Mention.

To Joseph S. Dunlap, of Philadelphia, for No. 394, a jar of candy, the best exhibited. A Certificate of Honorable Mention.

The display of confectionary, by Mr. Parkinson, is very creditable, and evinces a high degree of excellence in this branch of manufacture. The beautiful pagoda, seven and a half feet high, of transparent candy, which ornamented the summit of the centre circular table, in the exhibition room, was made by him, and added much to the effect of the general view. A Certificate of Honorable Mention.

The Committee proposes to submit those of the reports of the judges which are most interesting, to the Committee on Publication of the Institute.

Practical & Theoretical Mechanics & Chemistry.

New Act of Congress providing for the Registering of Designs, and for Amending the Patent Law in certain particulars.

It has long been a subject of serious and just complaint that the laws of the United States did not afford any protection to the art of designing, as applied to a number of manufactures; the subjoined act of Congress removes this difficulty, giving an exclusive right to the author, or inventor, of any new design, for seven years. This protection will be very extensive in its application, and in a number of instances where patents have been refused under the laws previously existing, they may be obtained under that now presented. Many very ornamental patterns, for example, have been made for stoves, which have been got up in good taste, and at great expense; but as the article did not present any thing new in the principle of its construction and operation, a patent could not be granted for it.

There are a great number of cases in which it will not be possible to comply with the requirement of the last section of this act. If a person obtains a patent for improved pins, needles, nails, or screws, or for an improved liquid for burning in lamps, he will be at some loss in attempting to "stamp on each article vended, or offered for sale, the date of the patent." This appears to be a strange oversight in the wording of the law. If it had provided that whenever the word patent was stamped upon an article, it should be accompanied with the date of the patent, the thing would have been practicable. The phraseology of this section is obscure in other respects.

An Act in addition to an Act to Promote the Progress of the Useful Arts, and to Repeal all Acts, and parts of Acts, heretofore made for that purpose.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Treasurer of the United States be, and he hereby is, authorized to pay back, out of the patent fund, any sum or sums of money, to any person who shall have paid the same into the Treasury, or to any receiver or depository, to the credit of the Treasurer, as for fees accruing at the Patent Office through mistake, and which are not provided to be paid by existing laws, certificate thereof being made to said Treasurer by the Commissioner of Patents.

SEC. 2. *And be it further enacted,* That the third section of the act of March, eighteen hundred and thirty-seven, which authorizes the renewing of patents lost prior to the fifteenth of December, eighteen hundred and thirty-six, is extended to patents granted prior to said fifteenth day of December, though they may have been lost subsequently: *Provided, however,* The same shall not have been recorded anew under the provisions of said act.

SEC. 3. *And be it further enacted,* That any citizen or citizens, or alien or aliens, having resided one year in the United States, and taken the oath of his or their intention to become a citizen or citizens, who by his, her, or their, own industry, genius, efforts, and expense, may have invented and produced any new and original design for a manufacture, whether of metal or any other material or materials, or any new and original design for the printing of woollen, silk, cotton, or other fabrics, or any new and original design for a bust, statue, or bas relief, or composition in alto or basso relievo, or any new and original impression or ornament, or to be placed on any article of manufacture, the same being formed in marble or other material, or any new and useful pattern, or print, or picture, to be either worked into or worked on, or printed, or painted, or cast, or otherwise fixed on, any article of manufacture, or any new and original shape or configuration of any article of manufacture not known or used by others before his, her, or their invention or production thereof, and prior to the time of his, her, or their application for a patent therefor, and who shall desire to obtain an exclusive property or right therein to make, use, and sell and vend the same, or copies of the same, to others, by them to be made, used, and sold, may make application in writing to the Commissioner of Patents, expressing such desire, and the Commissioner, on due proceedings had, may grant a patent therefor, as in the case now of application for a patent: *Provided,* That the fee in such cases, which by the now existing laws would be required of the particular applicant, shall be one-half the sum, and that the duration of said patent shall be seven years, and that all the regulations and provisions which now apply to the obtaining or protection of patents, not inconsistent with the provisions of this act, shall apply to applications under this section.

SEC. 4. *And be it further enacted,* That the oath required for ap-

plicants for patents may be taken, when the applicant is not for the time being residing in the United States, before any minister, plenipotentiary, charge d' affairs, consul, or commercial agent, holding commission under the Government of the United States, or before any notary public of the foreign country to which such applicant may be.

SEC. 5. *And be it further enacted,* That if any person or persons shall paint or print, or mould, cast, carve, or engrave, or stamp, upon anything made, used, or sold by him, for the sole making or selling of which he hath not or shall not have obtained letters patent, the name or any imitation of the name of any other person who hath or shall have obtained letters patent for the sole making and vending of such thing, without consent of such patentee, or his assigns or legal representatives; or if any person, upon any such thing not having been purchased from the patentee, or some person who purchased it from or under such patentee, or not having the license or consent of such patentee, or his assigns or legal representatives, shall write, paint, print, mould, cast, carve, engrave, stamp, or otherwise make or affix the word "patent," or the words "letters patent," or the word "patentee," or any word or words of like kind, meaning, or import, with the view or intent of imitating or counterfeiting the stamp, mark, or other device of the patentee, or shall affix the same, or any word, stamp, or device, of like import, on any unpatented article, for the purpose of deceiving the public, he, she, or they, so offending, shall be liable for such offence to a penalty of not less than one hundred dollars, with costs, to be recovered by action, in any of the circuit courts of the United States, or in any of the district courts of the United States having the powers and jurisdiction of a circuit court; one-half of which penalty, as recovered, shall be paid to the patent fund, and the other half to any person or persons who shall sue for the same.

SEC. 6. *And be it further enacted,* That all patentees and assignees of patents hereafter granted, are hereby required to stamp, engrave, or cause to be stamped or engraved, on each article vended, or offered for sale, the date of the patent; and if any person or persons, patentees or assignees, shall neglect to do so, he, she, or they, shall be liable to the same penalty, to be recovered and disposed of in the manner specified in the foregoing fifth section of this act.

JOHN WHITE,
Speaker of the House of Representatives.
WILLIE P. MANGUM,
President of the Senate pro tempore.

Approved August 29, 1842.

JOHN TYLER.

On the Manufacture of Sulphuric Acid. Read before the British Association for the Advancement of Science, by MR. WILLIAM BLYTH.

The ordinary process of manufacturing sulphuric acid, by introducing into a leaden chamber a mixture of sulphurous acid, red nitrous fumes, and common air, has been long practiced. Like many other

improvements in the arts, it seems to have been more the result of chance than the application of scientific skill; and chemists remained long in the dark as to the true nature of the changes which took place in the vitriol chamber. The first satisfactory explanation was given to the world by Clement and Desormes, in 1806. These chemists discovered the white chrystalline compound which is now known to be formed when sulphurous acid, red nitrous fumes, common air, and the vapour of water, are mixed together, and exposed to a sufficiently low temperature. They also observed the remarkable property which it possesses of being decomposed when put into water, and of being resolved into nitric oxide and sulphuric acid. This fact they applied to explain the important part performed by the nitric oxide, in enabling the sulphurous acid to be still farther oxydized at the expense of the oxygen in the common air. The formation of the crystalline compound in the leaden chamber, its decomposition by the weak acid at the bottom of the chamber, and the evolution of nitric oxide to be again changed into red nitrous fumes by the oxygen of the common air—is the favorite theory of chemists at the present time, and seems to be now generally admitted. M. Adolph Rose, of Berlin, has recently published a paper on the "combination of hydrated sulphuric acid with nitric oxide. The object of the paper is to show that the impurity in the sulphuric acid of this country, which has hitherto been considered to be nitric acid, is not nitric acid, but a combination of sulphuric acid and nitric oxide. He also shows that this compound of sulphuric acid and nitric oxide, is identical with the white crystalline formed in the vitriol chamber. There are some facts mentioned in this important paper which deserve attention; and it is more particularly the object of these remarks to bring them under the notice of those members of the Association who may be interested in the manufacture of this important acid. It is well known that, in the making of sulphuric acid, when the acid in the chamber reaches the specific gravity of 1.450, it is impossible to go beyond this point without increasing the proportion of nitre; and even with an increased proportion of nitre, the product of acid is less than it ought to be. The reason is, that sulphuric acid, of the specific gravity of 1.450, acts very slowly in decomposing the white compound; and acid of the specific gravity of 1.500, will not act upon it at all, but, on the contrary, it has a tendency to dissolve and retain it.

Mr. Blyth demonstrated these facts by experiments.

M. Adolph Rose states that when sulphuric acid, containing the compound, is concentrated by distillation, at one part of the process pure acid comes over; and when the acid in the retort has reached the specific gravity of 1.84, it will be found, if examined, to contain nitric oxide. It follows from this, that when sulphuric acid is raised in the chamber above the specific gravity of 1.500, it will be found, after being rectified, more or less contaminated with the nitrous compound. He made a number of trials, to ascertain the effect of the nitrous compound upon indigo. Some of the compound was dissolved, by the aid of heat, in sulphuric acid of specific gravity of 1.600. To this solution he added some drops of a strong solution of indigo in pure rec-

tified sulphuric acid. The blue color of the indigo was immediately destroyed. M. Adolph Rose also states, that, if rectified sulphuric acid, which is contaminated either with nitric acid or nitric oxide, be diluted with twice its bulk of water, and concentrated by distillation till it reaches the specific gravity of 1.84, the concentrated acid will be found to have been freed from both of these compounds. It follows, from this experiment, that in order to obtain sulphuric acid sufficiently pure to be used in the preparation of sulphate of indigo, it would only be necessary to draw the acid from the chamber at a low specific gravity, not higher, perhaps, than 1.300 or 1.350. Rectified sulphuric acid, prepared from acid drawn from the chambers at the above strength, if found to be perfectly free from all nitrogeneous compounds, will be a great acquisition to the woollen dyer in the preparation of his sulphate of indigo; and when we consider the large quantities of acid used for this purpose, it will be admitted to be a subject of great importance. Lond. Athenæum.

Carpet Tapestry.

Professor Vignoles exhibited specimens of newly invented carpet tapestry, at a meeting of the British Association for the Advancement of Science, and he explained that these works were made on the principle of the ancient mosaics, being composed of innumerable transverse sections of woollen threads. No painting, no coloring, was used; all the effect was produced by ends of worsted about one-eighth of an inch long, standing vertically, one end being seen, and the other cemented by India rubber to a cloth. The exact operation was yet a secret, but he believed that two frames of fine wire, or perforated zinc, (some with even 4,000 perforations in an inch,) were placed over each other, exactly vertically, the distance being only regulated by the height of the room, in the present instance he believed about five feet. The picture to be copied being then traced on the top side of the upper frame, a workman passed threads of dyed wool through the corresponding holes in the top and bottom frames, of course, as in tapestry, varying his shades and colors until he is satisfied with the effect; this he can judge of by looking down on the upper ends of the threads, although to a person looking at the space between the frames, there seems only a confused and compact mass of worsted. When the workman is satisfied, the upper ends of the threads are covered with India rubber cement, and a cloth is laid upon them also covered with cement; the ends of the threads firmly adhere to this cloth. By means of a sharp cutting instrument, the entire mass of threads is now cut through transversely, at about one-eighth of an inch from the cloth, and this process being repeated, a fresh copy is obtained from every one-eighth of an inch. In the present frames, being five feet apart, 480 copies can be cut, and as there is no limit to the distance, except in the height of the apartment, thousands of copies may be taken of each. Were this not the case, the invention, however ingenious, would be too expensive to be purchased, except in solitary instances as specimens of curious art; but, from the facility of reproduc-

tion, this fabric was likely to come into general use for carpets, rugs, curtains, table and chair covers, &c.; for carpets and rugs it could be made with a longer nap, so as to give any degree of substance.

Ibid.

On the Improvement of the Telescope.

At the twelfth meeting of the British Association for the Advancement of Science, Mr. Fox Talbot said, that this subject occurred to him about two years ago, when the Earl of Ross (then Lord Oxmantoun) was making much larger specula for reflecting telescopes than had ever been obtained before; and he thought, if once we had a very large and perfect speculum, it might be possible to multiply copies of it by galvanic means. He had observed, that if an electrotype cast were taken from a perfectly polished surface, the cast was also perfectly polished; so that no defect of form from this cause could have an injurious effect on the speculum. The great and obvious defect was, that electrotypes were in copper, which reflected but little light. He mentioned these ideas to Professor Wheatstone, who said the same had occurred to him, and he showed him a paper which he had drawn up some months before, and in which he suggested the taking of the galvano-plastic casts of specula in platina, palladium, silver, or nickel, and for especial purposes gilding the copper; taking care that the two precipitations adhered well to each other. So that (said Mr. Talbot) the idea had suggested itself independently to both of them; but, on comparing notes, they found differences. Though it had occurred to him (Mr. Talbot) to precipitate white metals, yet he did not think that platina would have a sufficiently beautiful white metallic polish. Professor Wheatstone had, however, made choice of platina, and, varying the quantity till he found the required proportion, he obtained a mirror in platina, which appeared to him (Mr. Talbot) to have quite brilliant polish enough, and to be white enough to answer the purpose; and he considered, therefore, that Professor Wheatstone had proved, that, at least in one form, the specula of telescopes might be made by voltaic precipitation. His own idea was, that it might be possible to whiten the surface of the copper without injuring the form; and, therefore, having obtained a speculum in very bright polished copper, he (Mr. Talbot) whitened it, and transformed it into sulphuret of copper, and after having retained it about a year, he did not perceive the smallest alteration in any respect. This, therefore, appeared to him a mode by which important results for astronomers could be obtained. For the last year, perhaps, nothing further had been done, either by Professor Wheatstone or himself; but, the other day, being at Munich, he (Mr. Talbot) visited Professor Steinheil, who showed him his inventions, and told him he had discovered a method of making specula by the electrotype. It so happened, that both Professor Steinheil and himself had published their respective methods about a month or six weeks before, the Professor having read a communication on the subject before the Academy of Science at Munich, and printed it, and he (Mr. Talbot) having

published his in England. Their modes were, however, different, as Professor Steinheil precipitated gold on the speculum of copper; and having precipitated a certain thickness of gold, he then precipitated copper on the back of the gold, to give it sufficient thickness. He (Mr. Talbot) should have thought beforehand that gold would not reflect light enough to be available; but Professor Steinheil informed him he had found, by careful experiment, that it reflected more light than polished steel. He allowed Mr. Talbot to look through a Gregorian reflecting telescope, of which the speculum was a common one, but gilded, and he found the image perfectly clear and well defined. A slight tinge of yellow was thrown over all the objects, but the image was perfectly clear and defined.

Professor Steinheil said, that in the course of a year he should have a very large telescope, furnished not only with a speculum, but also with other apparatus, voltaically formed, so that telescopes might be made all from a good model, so as to insure greater accuracy of proportions; and in this way even very large telescopes might be constructed, at a comparatively trifling expense. With reference to precipitating copper on the back of the gold, the Professor had a simple expedient for securing adhesion. He first precipitated gold from the cyanide of gold, and he mixed with it cyanide of copper, and kept gradually increasing the quantity of the latter sort, so that an alloy was precipitated, which was continually increasing the copper with respect to the gold, till he had a speculum whose surface was gold, and which then became an alloy, the quality decreasing, till, at the bottom, it became pure copper. This was important, because without such experiments, one would not have known that such results would have followed, for some philosophers supposed that if we attempt to precipitate the salts of two metals, only one was precipitated; but Professor Steinheil informed him that they precipitated in union. He thus obtained a speculum with a face of gold and a back of copper. Ibid.

On the Nature of Iron.

Mr. Nasmyth brought forward, at a meeting of the British Association for the Advancement of Science, several specimens to illustrate the remarks which he intended to make, in further illustration of former observations. From late accidents, arising from the breaking of axles, the public were alive to the subject, and it was desirable that the question should be examined. In locomotive engines, the axle was the chief point of danger, and it was, therefore, important, both as a scientific and practical question, to determine the nature and habitude of iron when placed under the circumstances of a locomotive axle. Experiment was the only way to discover this, and he would have wished to place iron under exactly similar circumstances, but the short time intervening since his last observations, had rendered it impossible to do so. One opinion at that time was, that the alternate strains in opposite directions, which the axles were exposed to, rendered the iron brittle, from the sliding of the particles over each other.

To illustrate this, Mr. Nasmyth took a piece of iron wire, and bent it back and forward; it broke in six bends. He had suggested annealing as a remedy for this defect—in proof whereof, he took a piece of annealed wire, which bore eighteen bends, showing an improvement of three to one in favor of annealing. He should, therefore, advise railway companies to include in their specification that axles should be annealed; he did not like the custom of oppressing engineers with useless minutiæ in specifications, but this was so useful and so cheap, that he considered it ought to be insisted on. To exhibit on a larger scale the effect produced on iron in our workshops, he showed a specimen of iron as it came from the merchant; being nicked with a chisel, it broke in four blows with a sledge, at the temperature of 60 degrees, with a crystalline fracture; by raising the temperature 40 degrees higher it bore twenty blows, and broke with the fibrous or ligneous fracture; so that the quality of iron was not the only circumstance to be considered as influencing the fracture. I noticed, also, (said Mr. Nasmyth) the injurious effect of cold swaging, as causing a change in the nature and fracture of the iron; and here let us take the practical workshop view of the case, and not run after the *ignis fatuus* of electricity or galvanism, but consider the practical effects. Swaging was necessary in many cases, for instance, when an axle had collars welded on, these could not be finished with the hammer, and certain tools called swages were used, from the action of which, great condensation of the iron took place, and a beautiful polish was given to the surface, with what injurious effect he would show by the next specimen, which had been heated red hot, and then swaged till cold; it broke at one blow, without nicking, and the fracture was very close and beautiful, like steel. This showed the fallacy of considering close fine grain a good test of excellence in wrought iron, but moderate swaging was often necessary, and not injurious, unless where an over regard to finish carried it to excess. To prove that annealing restored the toughness and fibrous texture, a portion of the last bar was heated, and cold-swaged till cold as before; then heated dull red, and left to cool gradually. It bore 105 blows without breaking, and at last was rather torn asunder than broken, as was shown by the specimen. This proved that the fibrous structure was restored by annealing, and he, therefore, thought it should be insisted on in specifications. The effect of heating to welding-heat was very injurious, unless the iron was subsequently hammered to close the texture. A piece of the same iron, heated to welding, and left to cool, broke without nicking, in one blow, showing very large crystals, especially in the centre. The effect of nicking was also very singular. The strength of iron was generally stated to be equal to its sectional area; but a nick not removing $\frac{1}{100}$ of the area, took away $\frac{1}{10}$ of the strength. Mr. Nasmyth broke a piece of nicked, or rather scratched, wire, to illustrate this point. These, and similar things, did not prove that science and practice were at issue; but, as Halley reached the great accuracy of his prediction of the return of his comet by taking into account the disturbing forces of Jupiter and Saturn, and the other planets amongst which the body had to pass, so scientific men should

seek in the workshops correctional formulæ, by learning there the practical occurrences which would elucidate their theories, and he hoped that these specimens might be of some use. Ibid.

Living under Water without communication with the Atmosphere. Dr. Payerne's Experiments.

One of the most remarkable experiments of modern times, was performed last week by a Dr. Payerne, at that excellent experimental school, the Polytechnic Institute, Regent street. Dr. P. descended in the great diving bell of that establishment, in his ordinary dress, and remained there for the space of three hours without any communication whatever with the upper air, and apparently without having been in the slightest degree affected or inconvenienced by his long submersion. He states that he could just as easily have remained down twelve or twenty-four hours; indeed he assigns no limit to his powers of subaqueous vitality. General Pasley, and several other eminent scientific individuals kept watch at the bell during the whole of the three hours, and were perfectly satisfied that no supply of vital air was conveyed to Dr. Payerne from above.

Now that this surprising feat, so long regarded as of the class of physical impossibilities has been at last accomplished, every one (as usual) is discovering how easy it is. It is only to take down with you something that will absorb the carbonic acid gas as fast as you generate it, and something else (with a lucifer match or two to heat it) from which you may get free oxygen enough to keep you alive. Doubtless these are the main conditions of the experiment—and there are several well known substances which do possess these two requisites. Pure potassa, for example, will absorb nearly half its weight of carbonic acid gas; and chlorate of potass gives out, when heated, 3915 parts per 100 of oxygen.

Dr. Payerne is said to be now engaged in constructing a subaqueous boat in which he will undertake to enter any enemy's harbour unseen, and in a single day apply the means of destruction to every ship it contains. Mech. Mag., May, 1842.

India Rubber Stoppers for Bottles.

At a meeting of the British Association for the Advancement of Science, Mr. Brockedon exhibited specimens of his patent India rubber stoppers for bottles, explaining the late improvements in the construction of the cores on which the India rubber is spread. The present cores, he said, were made of cotton twisted into strands, &c., by means of a machine which he explained by a diagram. The cylindrical rope now consisted of several strands of tightly twisted cotton, lapped with flax thread, and laid together longitudinally, loose fine cotton rovings being placed between them; the entire was then lapped in a cylindrical form with flax thread, attaining by this method the advantages of perfect roundness and firmness. They also gave sufficient hold to the corkscrew, and bore the heating process well. These

stoppers would slide on glass when wet, but not when dry (although there was no cohesion in this latter state,) so that the bottler, by slightly wetting these stoppers with the liquor which he was bottling, could easily insert them; and when this slight film of moisture was dried up, the stopper required considerable force to withdraw it.

Lond. Athenæum.

On Painting Timber.

We extract the following observations on painting timber when exposed to damp, by Mr. Lander, from the Professional Papers of the Royal Engineers.

I beg to lay before you a few observations which I have made on the construction and causes of decay in bridges, on the works at Devenport, having been employed on the erection of the bridge at the north-west barrier, in the years 1812 and 1813, and also on a large repair in 1837; and I am now employed on a similar repair at the north-east barrier bridge, which, I think, was built in 1816, which has induced me to make the following remarks:

1st. These bridges were paved with Guernsey pebbles, which, I think, was one cause of decay, as the wet constantly dripped through the joints, an evil which may be avoided by Macadamizing, by which such a compact body is formed that the wet cannot get through, and the joists and girders, &c., are thereby kept perfectly dry, besides the advantage of the vibration being very much reduced, as is the case now at the north-west barrier.

2nd. The wood work below, as well as the under side of the flooring, was frequently payed over with coal tar, which, forming a thick body on the surface, was another, if not the greater, cause of decay, as it completely prevented the air from acting on the wood, thereby keeping all moisture within, which of itself is sufficient to decay it. It must be observed that the plank, or flooring, was so rotten, that in many places it would not bear the weight of the workmen, and many of the joists and girders broke into pieces in removing them; some of them were found to be quite dry, and in a similar state to snuff.

3rd. As a further proof of the bad effects of the paying and paving bridges, I may state that the bridge at the south-east barrier across the old works leading to Stonehouse, the girders, joists, &c., of which have never been payed or painted, and the road above always Macadamized, remains sound and good at this time; and I know this to be a much older bridge than either of the former.

4th. I should state that the timber alluded to above is oak, but I think the same observations will apply to other timber, and in other situations, such as fences, for many posts and rails of the stockade fence here have frequently been found decayed, while in other and older fences, although much worn by time, yet not having been payed or painted, the fibre of the wood remains in a healthy state.

5th. I am also of opinion that skirting to walls, and linings to storehouses and other buildings, if not painted would last much longer, as the damp from behind would then be allowed to evaporate by the action of the external air.

Civ. Eng. & Arch. Jour.